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YEAR BOOK

1989



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YEAR BOOK 1989

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FOREWORD

It is heartening that Piggery India Year Book has been brought out by Dr. C.S. Sahukar as Chief Editor and with very eminent members of the Editorial Board. It contains technical information on scientific pig production, infrastructure development for pig production and marketing, guiding lines on breeding, feeding, management and health of pigs and feeding pigs on locally available feed resources and wastes.

Pig production has great scope for meeting our animal protein requirements as well as providing employment and income to the rural and urban poor. Pig production as an organised industry is yet to be taken up in the country, however, there is great scope and after poultry pig is the most efficient convertor of feed into animal protein.

Research and development work has been carried out by the Central and State Governments and these have been helping the pig producers in improving the pig production, lot more, however, needs to be done for increasing contribution of pig to the country's meat production and rural and urban employment.

In addition to the technical information on various aspects of production and health of pigs, it has a directory of pig breeding farms, bacon factories, pharmaceuticals, financial institutions, pig experts and equipment suppliers etc. The technical information and the information on various agencies providing inputs and service will help the entrepreneurs, who are interested for going in for pig farming.

I am certain that the book which has a wealth of information will help the farmers, veterinarians and other engaged in pig farming.

Dr. R. M. Acharya

Deputy Director General

(Animal Science)

Indian Council of Agricultural Research

NEW DELHI

Dated, 20th April 1989



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MESSAGE

I am happy to learn that Dr. Sahukar has taken over the responsibility to publish Piggery India Year Book. It has accomplished a good job for the development of this neglected species of the society.

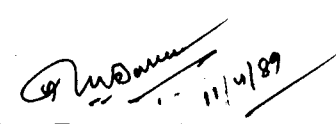
Pig farming which was considered a neglected concern has been gaining importance and momentum by way of attracting increased attention particularly in the North Eastern Region which offers ample scope for piggery development because of traditional dependence of the tribal population on pigs.

It is felt that there is a great shortage of animal protein in human diet in India and as such this gap must be narrowed down by multiplying all classes of meat animals particularly pig which is highly prolific, rapid grower and efficient feed converter so as to give protein of high biological value for millions of hungry masses in developing world.

It is hoped that Piggery India Year Book will cater the needs of the teachers, researchers, students and young affluent entrepreneurs to a great extent in the field of swine husbandry.

Dr. Sahukar deserves our appreciation.

With best wishes.


(Dr. P.C.Bora)

To

Dr. C.S.Sahukar
Chief Editor,
Piggery India Year Book,
C-2/333, Yamuna Vihar,
DELHI - 110053.

PREFACE

The Piggery India Year Book - 1989 is the comprehensive manual of skills, techniques, technical know-how and the most versatile tool available to the Indian Pig Industry. It captures a spectacular range of images from infrastructure to advanced technology of Pig production and processing and aimed both at the beginner and the experienced farmer or professional engaged in this industry.

Written, Edited and Contributed by a team of leading professional scientists and experts, it is the first complete compendium of its kind specifically planned for Pig farmers, Veterinarians, Bank Officials, Food Processing industrialists, Scientists and Government Officers engaged in this field.

It encompasses all the major aspects of the subject, from the fundamental needs itself to advanced technology and methods of approaching the modern industry fields. The technical knowledge and skill of scientists have been carefully conceived to help to farmers for achieving almost every possible desired effect for maximum profit. It outlines all the important aspects of Pig enterprise and would be helpful in developing a personal style for planning a project.

To foster a better understanding of the subject, it is divided in to several chapters, the "Special Articles" chapter enlightens the important and dynamic aspects of Pig Production. The contributors have tried to show most techniques and a variety of styles in common use relating to Organisation and structure of Pig Industry, Housing and Management, Nutrition and Feeding, Breeding and selection, Reproduction and Artificial Insemination, Health and Disease, Financing and Insurance coverage, Pork Processing Industries and Human Resources Development. The book ends with an alphabetically arranged Directory of a reference list of addresses for Pig production and Processing operation.

This book is a practical approach to Indian Pig Industry. I hope that, it will serve not only as an invaluable work of reference for every Pig industrialist, but also a source of inspiration for the development of Indian Pig Industry.

I seek the opportunity to express my deep sense of gratitude to the members of the Editorial Board, Dr. R.R. Mishra, Dr. R.C. Kulshreshtha, Dr. A.C. Deka, Dr. K. Krishna Reddy, Dr. S. Jogi and Shri M.D. Saxena for their generous guidance, help and endless encouragement and stimulating criticism throughout the course of editing.

In compiling this book I have endeavoured to record the best of current practice in this country and abroad. I am very grateful to the

contributors for their help and cooperation in imparting their experience and skill.

My heartfelt appreciations are due to Dr. R.M. Acharya, Deputy Director General, (Animal Science), Indian Council of Agricultural Research, New Delhi and Dr. P.C. Bora, Vice Chancellor, Assam Agricultural University, Jorhat for showing their enthusiasm for this exciting field.

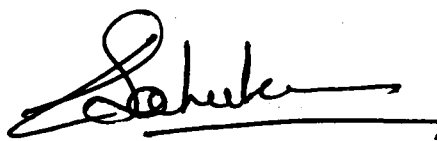
My sincere thanks are due to Dr. G.S. Singh, Deputy Commissioner (SH&BF), Ministry of Food Processing Industries, Dr. R.K. Pandit, Associate Professor, Department of Obstetrics & Gynaecology Veterinary College, MHOW, and Dr. R.K. Shrivastava, Professor and Head, Department of Biochemistry, Veterinary College, Mathura, for their encouragement and inspiration which enabled me to complete the challenging task.

Special acknowledgements are due to State Directors of Animal Husbandry, Manager Pig Breeding Farms, General Manager, Government Bacon Factories for providing co-operation and moral support. Special thanks are due to Advertisers for their support.

My sincere thanks are due to Dr. D.P. Sinha, Government Bacon Factory, Ranchi, Dr. R.K. Bhagarwal, Veterinary College, MHOW, Dr. Deshvat, Officer Incharge, Regional Pig Breeding Station, Aligarh, Shri A.K. Acharya, Assistant Manager, Government Bacon Factory, Central Dairy Farm, Aligarh, Mr. B.S. Gaur, Indian Council Agricultural Research and Mrs. Manjula Verma, Ministry of Agriculture for their help and encouragement.

My cordial appreciation to Mrs. Kusum Sahukar, Scientific Publishers and Distributors, Delhi for undertaking the challenging task of publication of this book.

Delhi,
Dated 30th April, 1989



(Chandra Shekher Sahukar)
Chief Editor

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INTRODUCTION

The increase pressure of Indian population and the need to raise living standard has created the scope for the production of more and better meat and its more effective preservation. The meat production from cattle, sheep and goats is unlikely to keep pace with the population increase because of the low prolificacy and a high generation interval. The expected increased meat consumption has thus to be met mainly by increased poultry and pig production. Meat animal produce high quality nutrients and protein for the human diet. Pork is a very important source of animal protein, inspite of religion, which forbid pork consumption. Modern pork production can play an important role in the supply of protein and nutrients of animal origin.

Pig production is essential for the future development of Indian meat industry. Pig is one of the most efficient food converting animals among domesticated stock. It is the only litter bearing animal among meat producing livestock having the shortest generation interval and high feed conversion efficiency. It converts feed and byproducts which have a high nutritional value in the human diet.

Pig rearing fits in very well with mixed farming and can also be complementary to intensive crop production operations. In India, pig farming has a special significance and can play an important role in improving the socioeconomic status of a sizeable section of the weaker community. Pig rearing is very popular amongst tribal population particularly in the North Eastern parts of the country. Government has extended a great help to the weaker sections of the society by arranging subsidy and loans for pig rearing through various schemes.

The pig industry contributes to the Nation's economy to a great extent as the pork and pork products form 7.5 percent of the total meat production. In recent years, with the introduction of purebred stock and improved method of breeding, feeding, management and meat handling, this industry is expected to play a significant role in the economy of the country. Rearing of pigs involves a nominal investment and can be practiced as a cottage industry.

The production potential of indigenous breed is very low. In recent times, pig breeds have been selected to produce lean meat. Genetic improvement of indigenous breeds, adapted exotic breeds and their crosses has to be carried out under existing management and feeding system in order to produce suitable high producing genotypes for different system.

Feed accounts about 80 percent of the total cost. For profitable pig production, efficient use of cheaper rations based on locally available materials and agricultural byproducts are essential. Modern technology

of swine feeding is consists of meeting the biological needs with proper combination of feed ingredients and locally available byproducts to yield an economical and nutritionally balanced diet.

For efficient pig production, emphasis should be given on the following factors of production: breeding at 6 to 7 months of age, farrowing at 10 months of age, maximizing ova fertilization, implantation and placentalation with maximum embryo survival (10-12 pigs farrowed/litter), minimizing neonatal losses, weaning 9-10 pigs/litter after 3 weeks of lactation and rebreeding at first oestrous (5-7 days post weaning) will allow upto 2.5 litters/sow/year and upto 25 pigs marketed/sow/year. Pig production on modern lines utilizes hormone implants or other anabolic agents to maximize protein accumulation and feed conversion efficiency.

Pork and pork products are perishable commodities. Pork processing technology offers opportunities for the integration of the knowledge for the betterment of the mankind, permits the sale of pork and pork products all year round and enables an adequate supply of these products to be made available in densely populated regions at an economical price. The Government bacon factories have the capacity to produce wholesome pork and pork products under hygienic conditions. Fresh pork, bacon, ham, smoke products, sausages and canned meat are being produced in the country.

The rapid expansion of the pig farming has resulted in the development of high technology and its introduction into the production process to the farmers. The technical know-how is based on scientific research. Scientific research is performed at a number of institutions and All India Coordinated Research Project on Pigs which together account for the development of Indian pig industry. Training imparts skills in farmers and persons engaged in pig production and pork processing. Improved communication techniques helps extension worker for effective transfer of technology of research.

The Government of India and Banks provides favourable climate for the farmers without directly involving itself in the economic process. The Nationalised banks through a large branches network provides financial assistance at a concessional rate.

Genetic engineering involving embryo transfer techniques and immunogenetics will produce pigs that are both productive and disease resistant. Application of the technology of embryo transfer in pig industry offers a considerable opportunity for effective exploitation of the genetic potential of the sow. The sexing of embryos will prove a powerful tool in the advancement of the breeding programme, which would be advantageous in increasing genetically improved meat type sows within a short period of time.

India has a excellent possibilities for a flourishing pig industry. Stimulation of this industry can to a great extent help to; solve the food problem, utilization of agricultural by-products, diversify agricultural production and employ available manpower resources.

CHAPTER II

SPECIAL ARTICLES

THE INTEGRAL STRUCTURE OF PRODUCTION OF PORK
AND PORK PRODUCTS IN INDIA**Dr. Nagendra Sharma**Division of Livestock Products Technology
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Pig production is considered one of the important activity of animal husbandry programme specially for the improvement of economic status in tribal belt and North-Eastern hill states of the country. There is no integration of breeding activities with those of slaughtering and processing as a result it is difficult to have a reliable statistics regarding pig population, pork production and quality of the pork. However, as per 1982 census the total pig population was 10 million and out of that 1 million are slaughtered annually. Total pig meat production in 1983 amounted to 0.076 million tonnes and valued Rs.121.6 crores.

General production practices and improvement efforts

The structure of production and processing of pig in India is a mixture of individual ownership, government farms and processing units. The pig keeping is mostly managed by section of weaker rural community as side business. The government farms have only breeding herds and culled or surplus breeding stock is sent to bacon factories for processing.

Feed is the most important aspect in pork production but this has been sadly neglected. Producers are almost entirely dependent on their own resources of feed and most of the time scavenging is the major way of feeding. Availability of compound feed is limited to Government breeding farms.

In North-Eastern hill region where pig meat is fetching maximum price, the raising of pig is just a backyard business. Most of the time the pigs are reared on kitchen and human waste. Some supplementary feed is provided occasionally. In Arunachal Pradesh, houses are mostly built on raised platforms over wooden pillars. The ground under platform is used as sty and kitchen waste falls directly to them as their feed. Some times wild banana are cooked and provided to them as additional feed. In other parts of the country, the private owners maintain their pigs in back-out-room of the house or in some discarded room of the house. They are confined there during night and left in morning for scavenging. In the evening some rice bran is provided to them as feed.

Balanced feed at reasonable price is a must for pig production programme. There is need to design starter diet which can be easily

digested by young and growing pigs. In developed country milk powder and partially cooked cereals are fed to young pigs. Such diets promote good performance, but they are expensive. The lower cost diet for young pig should be formulated with appropriate level of protein and energy. Adult stock also can not entirely meet even the maintenance need for energy from forage crops alone, because of the large amount of fresh material which has to be eaten to provide the necessary amount of digestible energy. Some cereal and oil-seed cake are essential requirement in the diet formulation which can supply energy and protein necessary for production. Certainly some cereal can be reduced by proper utilisation of agro-industrial byproducts to make the feed economical.

To improve pig production in the country some efforts were made after independence and during second to the fifth five year plan; 7 regional pig breeding farms, 8 bacon factories, 55 pig breeding units and 140 pigery development blocks were established in different parts of the country. The primary objective of the regional pig breeding farms is to improve the breeding stock for distribution to pig breeding units for further multiplication. Pig breeding units are supposed to distribute improved pigs among farmers for cross-breeding the local indigenous stock. The second objective of regional farm is to supply culled and surplus stock to bacon factories.

During the last decade, pig breeding programme was also undertaken through coordinated research programmes of ICAR and research centres were established at state agricultural universities mainly for assessing the performance of exotic breeds in different agroclimatic conditions. Landrace and Large White pigs appear to have acclimatized to Indian farm conditions. The indigenous pigs are much inferior to any of the exotic breeds in almost all the economic traits. It has been observed that an indigenous pig attains a body weight of 35-45 kg in 18 months of age whereas an exotic or graded pig can attain a weight of nearly 70 kg between 9 months and one year. However, some indigenous varieties of pigs available in Andhra Pradesh, Assam, Bihar and Meghalaya attain body weight of 65-75 kg at 18 months. The preferred international marketable body weight of 90-95 kg is attained by the improved exotic pigs in about six months or even earlier in the developed countries.

It may be pointed out that the number of pigs of exotic breeds in this country are small compared to the large number of indigenous pigs. This situation is likely to continue in coming many years. It is, therefore, extremely essential that studies may be conducted to assess the performance potential of the indigenous pigs under optimum managemental conditions. Such study has been initiated at pig production farm at IVRI and few centres of the veterinary colleges, but their results are still awaited. There is marked preference for black pigs in most of the North-Eastern states. Hence, crossbreeding with Hampshire, Saddleback or Berkshire may be more desirable in this region.

Processing and marketing

There is no practice of carcass classification and grading. The pigs are sold and purchased just on weight basis. Both direct or indirect marketing channels are operative. Private pork processors directly visit to village pig producers and purchase their requirement of stock. Some-time pigs are brought to livestock weekly fair (local hat) and private butcher purchase directly from producers. Commission agents are also operating in many parts of the country who purchase pigs from producers and sell to processors. From rural area they are transported on hoof and assembled at roadside collection points from where they are carried by truck.

For slaughter and processing of pigs reasonable facilities are available in bacon factories and in few slaughter houses in the country. In Deonar slaughter house complex of Greater Bombay, there is a separate slaughter house for pigs. Still major pork is produced by private owner. Private processors purchase mostly indigenous pigs from rural areas and slaughter them in their own premises where they are sold as fresh pork. In bigger cities like Delhi, private processors have come up and are operating under licence of Meat Food Products Order (MFPO). To some extent MFPO licency processors have better facilities for slaughter and processing as compared to rural private pork shop where hygienic condition is poor and burning is still commonly practised for scalding of the pigs. Majority of pork and pork products are produced from indigenous pigs in licensed shops too. Reason being the non-availability of enough exotic pigs and prevalent sale of low price pork through indigenous pigs.

Most of the bacon factories are operating on improved pigs and moderate slaughter facilities - stunner, scalding, dehairer, carcass splitter etc. are available. Bacon factories also have products processing equipments at least for production of ham, bacon and some kind of sausages. Due to non-availability of sufficient pigs as per installed capacity of 8 bacon factories, most of them have been converted to composite meat plants where other meat animals are also handled.

In a recent survey, the author has observed sale of ham, bacon, sausages and burgers in Delhi but none of the processing unit were having a good brine injector or bowl chopper. Private processors manage their work with manual or electric operated meat mincer for most of the ground meat products like sausages and burgers. Traditional type single injector and curing tank are available for curing of ham and bacon. Products are presented for sale in aesthetically appealing way in sale cabinet. Packaging of product in cellophane bags is also not uncommon. However, proper shrink pack, vacuum packaging for cured products and chub pack for ground products are still required to minimise colour fading and deterioration of the product's quality.

Research development

Research related to pig production has been a multi-disciplinary approach, for example research on growth, role of nutrients and nutrient requirement for maximum performance, the selection and improvement of pigs for growth and carcass traits and processing of various pork products etc. In addition, there have been numerous studies on litter size and growth rate in relation to pattern of bone, muscle and fat in animals. These kinds of considerations have become an integral part of animal production research programme in India, but their extension to pig production for increasing the pork production efficiency have not been implemented simultaneously. Usually industries are the user of research findings but in our countries there is no coordination between research institutions and pork trade.

Research institutions like Indian Veterinary Research Institute (IVRI), Central Food Technological Research Institute (CFTRI) and meat departments of Agricultural Universities have worked on development, quality control and keeping quality of products as per the Indian taste and condition. Recipes for processing of ham, bacon, accelerated curing process, pork sausages, pork pickles, ground pork and pork tikka have been developed at Livestock Products Technology Division of IVRI. Some of these products are discussed in brief.

Ham and Bacon

In sixties considerable research development efforts have been made at CFTRI and Veterinary College of Madras and Tirupati to produce cured and smoked ham and bacon by dry and immersion curing methods. Satisfactory results were achieved for production of bacon and ham with a long shelf life at ambient temperature. However, these methods have three limitations - slow process, chances of uneven curing and strong salty products. In early eighties the LPT Division of IVRI has standardised technology of injection curing and accelerated hot curing of ham and bacon. Brine composition for hot curing of ham and bacon was developed by dissolving 250 g salt, 100 g sugar, 2 g sodium nitrate, 2 g sodium nitrite and 50 g sodium phosphate dibasic in 1 litre of distilled water. Injection was made at the rate of 100 ml brine per kg in pre-chill ham and bacon.

Quick curing method of ham slices has also been developed. Accelerated hot processing techniques of ham and bacon reduced the conventional curing period from 10-15 days to 1-2 days and considerable saving is possible to producers. Besides short curing time, the evenness of salt distribution in ham and bacon has improved and mild cured products were produced.

In developed countries new technologies of massaging and tumbling

are deployed to improve the product quality. Through these methods fabricated ham can be produced from carcass portion other than ham. After injecting curing solution through multi-needle injector, the meat is mechanically treated in massager or tumblers. These treatments improve speed of distribution of curing ingredients and the extraction of salt soluble proteins (myosin, actin etc) for binding the pieces together in desired configuration. In finish product, the binding is normally improved during cooking.

Pork sausages

The Division of LPT at IVRI has developed know-how for various types of pork sausages. Appropriate lean:fat ratio and spice mixes for Indian tastes have been evolved. Highly acceptable, low cost recipes of pork sausages by incorporation of soy flour, texturised soy proteins, potato starch and maida were developed. Yield and quality of pork sausages and salami were increased by use of polyphosphates in the recipes.

Pork patties

Recipes and techniques for manufacturing pork patties have been evolved. Highly acceptable indigenous flavour profiles of onion, garlic, ginger and their combinations have been developed for pork patties. Meat particle size and mixing schedule has been standardised to increase texture and cooking yield of the patties. Palatability and overall acceptability of these convenient products are excellent under Indian condition and can be sold as fast food items.

Pork tikka

Recipes for pork tikka were developed after exploring various combination of extenders with its specific texture which are different from patties. Acceptable recipes of pork tikka are presented in Table. Recipes containing 10% shredded potato and combination of shredded potato with 5% each of bread crumbs and rice flour were considered superior for most of the sensory scores.

Ground pork (keema)

Convenience pack of ground pork with low fat contents and extended with different levels of texturised soya proteins have been developed. Studies at the Division of LPT, IVRI have confirmed that there is no need to use higher fat level and 15-20% fat level is optimum for an excellent organoleptic acceptability of such products. Texturised soya proteins (TSP) can be used upto 20% replacement of lean without any undue effect on organoleptic acceptability.

Table-1: Recipes of pork tikka.

Pork pickle

Pork pickle is traditionally ready-to-eat meat product of indigenous origin. Pork pickle is very popular specially in Northern India and have a shelf life without refrigeration. Division of LPT, IVRI has developed pork pickle recipes with bone-out lean pork and bone-in pork with 25 and 50% backbone cubes.

Ingredients (%)	1	2	3	4
Minced meat*	76.0	66.0	56.0	46.0
Onion	6.0	6.0	6.0	6.0
Garlic	1.5	1.5	1.5	1.5
Ginger	1.5	1.5	1.5	1.5
Common salt	1.5	1.5	1.5	1.5
Dry spices	1.5	1.5	1.5	1.5
Maida	2.5	2.5	2.5	2.5
Fat	10.0	10.0	10.0	10.0
Shredded potato	-	10.0	10.0	10.0
Bread crumbs	-	10.0	10.0	10.0
Rice flour	-	10.0	10.0	10.0
Wheat flour	-	10.0	10.0	10.0
	100.0	100.0	100.0	100.0

* Raw meat 60% + cooked 40% (pressure cooked at 1.05 kg/cm² for 2 minutes).

For production of fermented type of sausages three fermentation methods are used - (1) starter culture which represents a concentrated blend of one, two or several specially selected strains of lactic acid producing bacteria. The most common organism is use of *Lactobacillus plantarum*, *Pedococcus cerevisiae* and *Micrococcus aurantiacus*. (2) Natural fermentation method where natural contaminants of meat or utensils are allowed to grow and (3) The back stop method, where saving back a small quantity of sausage batter from one day's production for use in the next day's production is practised. In the last two methods, chances of growth of wild and undesirable bacteria increase.

Pork pickle

Pork pickle is traditional, ready-to-eat meat product of indigenous origin. Pork pickle is very popular specially in Northern India and have a shelf life without refrigeration. Division of LPT, IVRI has developed pork pickle recipes with bone-out lean pork and bone-in pork with 25 and 50% backfat cubes.

Pork snacks (Rindex)

Very crisp and tasty snacks from pork rind has been developed after curing and cooking. The product can be sold and consumed like pop-corn.

Pork kofta

Recipes and processing techniques for pork koftas have been evolved. The best quality of pork kofta can be prepared by adding a combination of 2.5% maida alongwith 5% whole egg liquid. It has been observed that whole pork kofta can sustain intensive cooking and binding is not a problem. However, incorporation of egg liquid has improved cooking yield, juiciness and texture of the product.

Fermented sausages

Fermented sausages are commonly produced by inoculating sausage products with a bacterial starter culture composed of lactic acid producing bacteria. Such sausages are more common in Goa. There are two categories of fermented sausages - dry and semi-dry. Based on their water activity (Aw) dry and semi-dry sausages are categorised. Fresh pork has an Aw of 0.99 and is an ideal medium of micro-organisms to grow. Semi-dry sausages will typically have an Aw of 0.90 to 0.95. Dry sausages have Aw values in the range of 0.60 to 0.85. Very few bacteria are capable to grow and cause subsequent product spoilage at an Aw level below 0.88 but molds are capable to grow at an Aw levels as low as 0.66. As a result molds are often problem in dry sausage processing.

For production of fermented type of sausages three fermentation methods are used - (1) starter culture which represents a concentrated blend of one, two or several specially selected strains of lactic acid producing bacteria. The most common organism in use of Lactobacillus plantarum, Pediococcus cerevisiae and Micrococcus aurantiacus, (2) Natural fermentation method where natural contaminants of meat or utensils are allowed to grow and (3) The back slop method, where saving back a small quantity of sausage batter from one day's production for use in the next day's production is practised. In the last two methods, chances of growth of wild and undesirable bacteria increase.

Simple sugar such as dextrose is essential ingredient in fermented sausages. Lactic acid bacteria requires simple sugar for rapid growth. Common level of dextrose used range from 0.5 to 1.5 percent of the formulation. Fermentation temperature is critical. Period of fermentation ranges from 8 hours to 2 or 3 days, depending on temperature. Temperature may range from 27°C to 44°C with RH of 75%. The order of ingredient addition is also important in production of fermented sausage. In general salt is the last ingredient to be added to obtain a desirable texture.

Semi-dry sausages should be cooked to 148°F. Dry sausages are not cooked and, therefore, must be made from high quality and trichinae free pork. Such products can be sold without refrigeration.

Besides these processed products, several canned pork products have been developed. Many other new technologies are under development for improved production, processing and quality control of pork and pork products.

Single sugar such as dextrose is essential ingredient in fermented sausages. Common level of dextrose used range from 0.5 to 1.5 percent of the formulation. Fermentation temperature is critical. Period of fermentation ranges from 8 hours to 2 or 3 days depending on temperature. Temperature may range from 27°C to 44°C to 75°F. The order of ingredient addition is also important. In general salt is the last ingredient added to give desirable texture.

PIG INDUSTRY AND PERFORMANCE OF DESI PIGS IN INDIA

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Semi-dry sausages should be cooked to 142°F. Dry sausages are not cooked and therefore must be made from high quality and rich in fat. Swine are known to have played an important role in the mythology and religion of the ancient Greek, Egyptian and Semitic records. The Chinese scholar's believed that swine were domesticated in Eastern Asia as early as 2900 B.C. India has a very long history about pig. In literature, there is a reference that God, in the form of Varan Avatar has saved the human race from the Mahaplayavan in ancient times.

In Europe, pigs (Sus serota) were domesticated somewhere around the Baltic sea in Neolithic times by crossing domestic with wild pigs. In Asia, pigs (Sus vittatus) were separately domesticated in China, perhaps as long ago as 3000 B.C. from the native pigs of middle and Eastern Asian mainland which included Western India to Central China and some of the islands like Japan, Sumatra and Borneo.

An immense wealth of livestock is possessed by India. The National Commission on Agriculture was of the opinion that next to crops, animal husbandry has got largest employment potential both direct and indirect. Indian Institute of Public Opinion confirmed the view that there exists tremendous potential for employment and earning with a subsidiary occupation in livestock production, pig being one of the important among them. Fortunately the productive capacity of our animals (Sus serofa domesticus) is upto the mark as compared to other countries of the world in terms of its dual performance providing economy through quality bristle and pork to pig farmers.

Feeding a more balanced diet to the population of 800 million having different dietary habits is a difficult task. Mere increase in the production of cereals alone will not meet the demand but exploiting sources of both vegetable and animal origin is also important. There is an ever increasing demand both for nutritious and balanced food because of the mass tendency of improving the standard of living both in urban as well as in rural areas.

The rapid growth of population is resulting in continued widening of the gap between the demand and supply of the required quantity and quality of the food. The major deficiency in the diet of an average man is that of protein. The per capita consumption of meat is 1.7 kg per year in India. According to modern concepts the requirement of meat

works out to be 32.00 kg per year.

In order to bridge the wide gap between large requirements and low availability of animal protein, it is essential to improve and multiply all meat producing animals in the country. Improvement in the production of mutton, chevon, and beef etc. may not be sufficient to meet such demand because the ruminants like cattle, buffaloes and sheep in general have a low rate of weight gain. Moreover, in species like cattle and buffaloes, the generation interval is longer. The increased demand for meat can be met through pigs and poultry as they do not have such biological restraints for high rates of production because of their rapid rate of growth, economic feed conversion efficiency, high prolificacy and short generation interval.

Table-1: Feed consumed gain and efficiency at various weights

Live weight (lbs)	Air dry feed (lbs)	Daily gain (lbs)	Feed per 100 lbs gain (lbs)
25	2.0	0.8	250
50	3.2	1.2	267
100	5.3	1.6	331
150	6.8	1.8	378
200	7.5	1.8	417
250	8.3	1.8	461

Adapted from: Feeds & Feeding Abridged by Frank B. Morrison

Thus pigs can play an important role in increasing meat production and thereby to meet the protein hunger. Pigs are also valuable source of rich animal protein at a low cost. They excel all other farm animals in respect of edible flesh. Pig industry gives high returns with a low investment, so the popular name 'mortgage lifter' is often given to them.

There are more than one crore pigs in the country. Although pig is one of the most efficient feed converting and fast weight gaining animal, indigenous pigs are poor in production performance compared to exotic pigs. In order to improve the economic traits of the indigenous swine herds cross breeding and upgrading programmes with the use of exotic pigs have been undertaken. There are 95 pig breeding multiplication centres which are maintaining crosses of these exotic pigs as well as crosses of exotic breeds with indigenous pigs for the benefit of the farmers.

The demand of exotic and cross bred piglets is on an increase as these are early maturing, rapid growers and highly prolific and economic to rear.

Keeping in view the demand for quality pork and pork products and also to help the primary producers who sell their produce at a remunerative price, eight regional becon factories are operating in Andhra Pradesh, Bihar, Punjab, Uttar Pradesh, West Bengal, Kerala, Maharashtra and Rajasthan. Besides these, there are 140 meat processing units which are operating in the private sector which are also processing pork and pork products under hygienic conditions. the total turnover of these States owned meat processing plants are to the tune of Rs.200 lakh.

India's pig industry is on the threshold of a good many changes that would totally transform the piggery scene and give the needed thrust to its rapid growth. To meet the challenges ahead, greater emphasis needs to be placed on facilities in the areas of pork production, processing, marketing and research.

The hog industry in India has not yet developed like poultry, dairy, and wool industries because pigs are not generally used for meat purposes by majority of the meat eaters and they compete directly with human beings for cereal grains. The common village hog in India is a scrub animal small sized, produce small litters, slow grower and has a pork of low quality. The only explanation for this may be because of the fact that they do not get a fair chance to grow into economical animals for industry because they are virtually scavengers. This is perhaps the most remunerative system for the swine keeper because with little input the return is better. Hence it can be concluded that even though hog industry may develop in India to any extent but piggery shall continue to be a subsidiary occupation and a major source of income for backward class and landless tribes of India. In any scenario for tomorrow's piggery nondescript pigs (Sus-scrofa domesticus) will remain the back bone of pig farming in India.

It is, therefore, of vital importance to study the potential of the various performance traits of the non-descript pigs of which very little is known till today.

The common non-descript indigenous pig (Sus-scrofa domesticus) is black to blackish grey in colour. It grows the world's best quality bristles concentrated over the neck, thorax and lumber to sacral region. The adult males weight usually 70-90 kg with 32 to 34 inches length, 45 to 50 inches heart girth and 33 to 35 inches in height. Females weigh usually between 65-80 kg with 30 to 33 inches in length, 45 to 50 inches heart girth and 31 to 33 inches in height. The mean, standard error, standard deviation and coefficient of variation percentage for various pig performance and sow productivity traits of Sus scrofa domesticus are shown in Table 1 to Table 4.

Table-2: Mean, S.E., S.D. and C.V.% for growth characteristics

S. No.	Traits	Mean $\pm$ S.E.	S.D.	C.V.%
1.	Birth weight	0.73 $\pm$ 0.00	0.11	16.02
2.	Weight at 1st week	1.54 $\pm$ 0.01	0.28	18.49
3.	Weight at 2nd week	2.38 $\pm$ 0.01	0.38	16.24
4.	Weight at 3rd week	3.22 $\pm$ 0.01	0.48	15.01
5.	Weight at 4th week	4.05 $\pm$ 0.02	0.55	13.76
6.	Weight at 5th week	4.86 $\pm$ 0.02	0.62	12.76
7.	Weight at 6th week	5.71 $\pm$ 0.02	0.70	12.32
8.	Weight at 7th week	6.59 $\pm$ 0.02	0.77	11.75
9.	Weight at 8th week	7.59 $\pm$ 0.03	0.90	11.93
10.	Weight at 12 week	9.87 $\pm$ 0.15	4.23	42.86
11.	Weight at 16 week	13.19 $\pm$ 0.12	3.38	25.61
12.	Weight at 20 week	17.26 $\pm$ 0.16	4.24	24.59
13.	Weight at 24 week	21.99 $\pm$ 0.19	5.01	22.79
14.	Weight at 28 week	26.72 $\pm$ 0.17	4.42	16.54
15.	Weight at 32 week	31.78 $\pm$ 0.21	5.39	16.99
16.	Weight at 36 week	34.63 $\pm$ 0.30	5.80	16.75
17.	Weight at 40 week	38.75 $\pm$ 0.31	6.08	15.69
18.	Gain in weight between 0-2 weeks	1.66 $\pm$ 0.01	0.47	28.63
19.	Gain in weight between 2-4 weeks	1.68 $\pm$ 0.01	0.48	28.97
20.	Gain in weight between 4-6 weeks	1.68 $\pm$ 0.01	0.44	26.48
21.	Gain in weight between 6-8 weeks	1.93 $\pm$ 0.02	0.60	31.18
22.	Gain in weight between 12-24 weeks	12.37 $\pm$ 0.17	4.51	36.43
23.	Gain in weight between 24-36 weeks	13.65 $\pm$ 0.21	4.08	29.90
24.	Average daily gain upto 40 weeks	0.13 $\pm$ 0.00	0.03	25.09

Table-3: Mean, S.E., S.D. and C.V.% for carcass characteristics

S. No.	Traits	Mean $\pm$ S.E.	S.D.	C.V.%
1.	Live weight kg	47.74 $\pm$ 0.52	7.95	16.65
2.	Dressed weight kg %	59.65 $\pm$ 0.15	2.39	4.01
3.	Weight of head kg %	9.38 $\pm$ 0.03	0.57	6.13
4.	Weight of liver kg %	2.19 $\pm$ 0.02	0.32	15.01
5.	Weight of kidney kg %	1.32 $\pm$ 0.02	0.33	25.65
6.	Weight of lungs kg %	1.10 $\pm$ 0.01	0.22	20.65
7.	Weight of heart kg %	0.28 $\pm$ 0.00	0.05	20.70
8.	Weight of spleen kg %	0.13 $\pm$ 0.00	0.03	24.66
9.	Weight of fat (legs, ears, tail) kg %	3.08 $\pm$ 0.03	0.47	15.70
10.	Weight of A tract kg %	16.58 $\pm$ 0.01	1.67	10.08
11.	Weight of fat kg %	3.77 $\pm$ 0.05	0.84	22.33
12.	Weight of Bacon kg %	5.93 $\pm$ 0.06	0.99	16.78
13.	Weight of ham kg %	15.61 $\pm$ 0.12	1.84	11.81
14.	Weight of shoulder kg %	12.13 $\pm$ 0.26	3.96	32.64
15.	Weight of Loin kg %	22.03 $\pm$ 0.14	2.25	10.22
16.	Length of carcass cm	56.70 $\pm$ 0.35	5.32	9.39
17.	Back Fat Thickness cm	2.88 $\pm$ 0.04	0.69	24.17
18.	Loin Eye Area sq. cm	20.01 $\pm$ 0.20	3.02	15.09

Table-4: Mean, S.E., S.D. and C.V.% for farrowing traits

S. No.	Traits	Mean $\pm$ S.E.	S.D.	C.V.%
1.	Litter size at birth	6.47 $\pm$ 0.07	1.12	17.29
2.	Live weight at birth	5.02 $\pm$ 0.05	0.82	16.44
3.	Litter size at 21 days	6.02 $\pm$ 0.07	1.20	20.09
4.	Live weight at 21 days	15.97 $\pm$ 0.02	3.47	21.77
5.	Litter size at 42 days	6.02 $\pm$ 0.07	1.20	20.09
6.	Live weight at 42 days	31.76 $\pm$ 0.42	6.61	20.82
7.	Litter size at 56 days	6.01 $\pm$ 0.07	1.20	20.08
8.	Live weight at 56 days	43.36 $\pm$ 0.58	9.02	20.82
9.	Age at conception (days)	226.62 $\pm$ 0.45	6.94	3.06
10.	Gestation period (days)	114.47 $\pm$ 0.09	1.50	1.31
11.	Age at farrowing (days)	340.39 $\pm$ 0.60	9.30	2.73

The future of India's piggery will be high tech, although its base will continue to be in the hands of vast number of small rural producers, scattered across the country.

PORK AS HUMAN FOOD

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A balanced diet is a diet which can meet the production and maintenance requirements of the body in terms of energy, proteins, fats, minerals and vitamins. These nutrients are available from different sources of food. The knowledge of nutritive value of different meat and other diet would be helpful for balancing the diet as per the recommendations of ICMR (Indian Council of Medical Research). The meat is a rich source of nutrients and the edible portion contains 17 per cent protein, 20 per cent fat, 62 per cent moisture and 1 per cent ash. It yields 250 calories per 100 grams of meat.

Meat is a competitor of other high protein foods of animal origin, such as cheese, eggs or fish. The consumer has a choice - cereal versus meat and meat products. The liking is due to enjoyment of flavour, aroma, juiciness, tenderness - that comes from crisp fried chicken, roast meat or cured ham or bacon. According to some advance the idea that there is "Prestige" in eating more meat. The comparative nutritive value of different meat would be helpful for selection of diets.

Meat and meat products are excellent sources of protein, vitamins, minerals and other nutrients. Its importance to the human diet is well established and recognised by nutritionists. The meat has been known to play a key role in providing a good source of the essential nutrients to man. A knowledge of the nutritional value of the meat and meat products including pork is of great significance for commercial workers engaged in pig industry.

The pork is a nutritionally rich and palatable human food. The pork ranks first in meat production, as it constitutes 37% of total world meat production (National Pork Producer's Council, 1982). In India, pork and pork products constitute only 7.4% of the total meat produced. Poor acceptance of pork by Indian people seem to have grown to the filth and unhygienic conditions of the traditional pig farming and unawareness of the nutritive value of pork and pork products.

Pork is an excellent source of high quality protein, B-Vitamins and trace elements. It is a highly nutritious food which contains a high nutrient ratio for the calories consumed. Cooking reduces the water content so that percentages of protein, fat, ash and calorie concentration are increased appreciably. Pork in the diet, even if only a small quantity,

can measurably improve the protein quality in the diet.

COMPARATIVE NUTRITIONAL CONTRIBUTIONS OF PORK AND OTHER ANIMAL PRODUCTS

Pork alike other animal products (milk, egg, chicken, mutton, fish) provides abundant sources of all known food nutrients. Comparative contributions of 100 gm edible pork and other animal products are shown in Table-1 and Table-2. These comparative statements indicates that pork is equally good in nutritive value when compared to other products of animal origin. Pork is especially rich in certain dietary nutrients which are essential for life.

PROTEINS: Pork is a valuable source of high grade protein

Proteins are the most valuable and universal nutrients, as they not only serve as the basic structural material for creating new cells and restoring old one; but also an energy source. The carbohydrates and fats are synthesized from proteins in the body. The proteins of pork and pork products are considered to be full valued as they contain essential aminoacids which include arginine, histidine, isoleucine, leucine, lysine, methionine, cystine, phenlalanine, threonine, tryptophan and valine. Protein malnutrition is more likely to occur with infants, children and pregnant women than in other population groups. It has been estimated that 20-30 percent of the children in India suffer severe protein calorie malnutrition. Protein deficiencies may play an important role in inhibiting development of immunity. Proteins also play important role in growth and maintenance of the integrity of body structure and vital functions. The amino acid compositions of the various animal protein is shown in Table-3.

Dietary protein is necessary not only to provide essential amino acids but also nitrogen for the synthesis of body proteins and other biological important substances. As per ICMR eight (nine in case of infants) of the twenty two amino acids present in the tissue cannot be synthesised by man and these have to be provided through food. Pork fulfills this requirement as it provides a better balance of amino acids than other animal products. Pork protein and casein are adequate in amino acid balance to support good growth, although casein is slightly deficient in methionine and cystine.

FATS: A good source of energy.

Pork is a good source of energy; the energy value being dependent mainly upon the amount of fat, it contains. The pork fats are mainly composed of triglycerides with small amount of mono and diglycerides, as well as free fatty acids. The human requires a certain amount of polyunsaturated fatty acids i.e. linoleic, linolenic and arachidonic. These acids have anticholesterol properties. Fats are essential dietary elements. Fatty acids are essential for good health. The pork fat known as lard. The unsatu-

Table-1: Nutrient content of pork and other animal products per 100 gm edible portion.

Animal product	Water g	Food energy Kcal	Protein g	Ash g	Fat g	Saturated fatty acids g	Unsaturated fatty acids g	Cholestrol mg
Pork, loin or chop	57.2	298	17.1	0.9	24.8	9.50	14.25	70
Egg whole	74.6	158	12.1	0.9	11.2	3.03	6.63	550
Milk, whole	87.7	64	3.3	0.7	3.6	2.05	1.25	11
Fish, cod	81.2	78	17.3	1.2	0.3	-	-	70
Chicken, white meat	73.3	117	23.4	1.0	1.9	-	-	60
Lamb, chop	53.4	339	15.1	1.1	30.4	17.55	12.73	70
Beef, round	66.6	197	20.2	0.9	12.3	4.70	5.75	70

Source: Modified from "Composition of foods" USDA handbook 8, 1963; "Composition of Foods: Dairy and Egg Products" Agriculture Handbook No.8-1, ARS, USDA. Revised November, 1976 and O.B. Hayes and G.Rose, J. Amer. Diet. Assoc. 33:27-28(1957).

Table-2: Mineral and Vitamin content of pork and other animal products per 100 gm edible portion.

Animal product	Cal- cium	Phos- phorus	Iron	Sodium	Potas- sium	Magne- sium	Fat soluble vita- min A	Water soluble vitamins			
								Thiamin	Riboflavin	Niacin	Vitamin C
	mg	mg	mg	mg	mg	mg	IU	mg	mg	mg	mg
Recommended daily allow- ance humans*	800	800	10.0 (18.0 women)	-	Est 1875- 5625	350 (300, women)	5000	1.1- 1.5	1.3- 1.7	14-18	60
Pork, ham	10	236	3.0	65	390	17	-	0.51	0.23	4.6	-
Liver, pork	10	356	19.2	73	261	16	10,900	0.30	3.03	16.4	23
Egg, whole	54	205	2.3	122	129	11	1,180	0.11	0.30	0.1	-
Milk, whole	118	93	Trace	50	144	13	140	0.03	0.17	0.1	1
Fish, Salmon	196	286	0.8	387	361	30	70	0.03	0.18	8.0	-
Chicken, White meat	11	265	1.3	64	411	19	60	0.04	0.10	11.6	-
Lamb, choic grade	10	147	1.2	70	290	23	-	0.15	0.20	4.8	-
Beef, good grade	10	152	2.5	65	355	18	60	0.07	0.15	4.0	-

Source: *National Academy of Science - National Research Council, Food and Nutrition Board, Washington, D.C. 1980., "Composition of Foods", USDA Handbook 8, 1963; and "Nutritive Value of American Foods" USDA Handbook 456, 1975.

Table-3: Amino acid composition of fresh pork, other animal products (Good Quality Proteins) and Wheat(a poor quality protein).

Amino acid	Percent of protein						
	Pork	Egg	Milk	Fish	Chicken	Beef	Wheat
Arginine	6.7	6.4	4.3	4.0	6.7	6.4	0.7
Histidine	2.6	2.1	2.6	1.3	2.0	3.3	0.3
Isoleucine	3.8	8.0	8.5	3.2	4.1	5.2	0.6
Leucine	6.8	9.2	11.3	5.1	6.6	7.8	0.9
Lysine	8.0	7.2	7.5	7.3	7.5	8.6	0.5
Methionine +Cystine	2.6	6.5	4.4	3.6	3.6	4.0	0.4
Phenylalanine	3.6	6.3	5.7	2.6	4.0	3.9	0.6
Threonine	3.6	4.9	4.5	2.6	4.0	4.5	0.4
Tryptophan	0.7	1.5	1.6	0.9	0.8	1.0	0.2
Valine	5.5	7.3	8.4	3.2	6.7	5.1	0.5

Source: Modified from M.L. Scott., J. Amer. Diet. Assoc:35:248(1959).

rated fatty acid content in pork is higher than that in beef and mutton fat.

In recent times, the demand for lean pork has been increased. Pork fat is a good source of polyunsaturated fatty acids. As pork contains a relatively high proportion of fat compared to other animal products but the average fatty acid composition varies from various body sites. The fatty acid composition of back fat is affected by sex. The fat composition is also affected to a great extent by diet. It is possible to produce pork with less fat by adoption of modern management and feeding practices using special diets.

MINERALS: Pork is a rich source of Phosphorus and iron.

Pork and pork products provide abundant sources of essential dietary minerals. Mineral components in several meats are shown in Table-2. Pork is a good source of Phosphorus but deficient in calcium. Pork liver is excellent source of iron. The biological availability of minerals in pork is very high. The cooking and processing of pork do not significantly affect the quantity or availability of the minerals.

Minerals are necessary to build and maintain the body skeleton and other body functions. Pork is high in potassium but rather low in sodium. It is a good source of iron, zinc and magnesium. The amount of these elements deposited in the liver of pig are related to the diet content of each mineral. Iron is vital in the formation of red blood cells and hemoglobin. It helps in prevention of anaemia. Iron from pork liver also increases the absorption of iron from vegetable sources. Potassium like sodium helps to stabilize osmotic pressure in side and outside of blood cells and muscle cells. Zinc hastens wound healing, bone growth, tissue development and enhances the sense of taste and smell. It is clear that not only pork but meat from other animals (except fish) are also deficient in calcium content. However, calcium needs of body can be met by including milk in the daily diet or by increase use of leafy vegetables.

VITAMINS: Pork is loaded with vitamin B Complex.

The vitamins although required in extremely small quantities, play vital roles in the health and well being of man. Although all known fat soluble and water soluble vitamins are contained in pork but the water soluble vitamins content of pork is higher compared to other meats. The content of Vitamin B₁ in pork is considerable higher than that of other meats. The pork liver is excellent source of vitamin A. The thiamine, riboflavin and nicotinic acids content of cured, processed and canned pork depends on the type of cuts and extent of heat processing.

The average concentration of vitamins in various types of meat has been shown in Table 2. Pork is specially high in thiamine. The 100

gm of pork loin provides 70 per cent of the daily requirement of thiamine. Thiamine is necessary for releasing energy from carbohydrates and maintenance of nervous system. Beef and lamb contain only 9 and 17 per cent of the amount of thiamine provided by pork. Pork also supplies high proportion of other B-vitamins including riboflavin, niacin, vitamin B₆ and vitamin B₁₂. All these vitamins are necessary for growth, efficient use of energy in the body, maintenance of nervous system. Pork is comparable to milk, beef and lamb as a source of riboflavin and niacin. Pork liver also supplies appreciable proportion of vitamin C.

**POST WEANING ECONOMY AND OVERALL COST OF PRODUCTION
IN LOCAL, EXOTIC AND CROSSBRED PIGS UNDER FARM AND VILLAGE
CONDITIONS OF ASSAM**

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The study was undertaken to estimate post-weaning economy and overall cost of production under Farm and village conditions. Considering constraints of physical facilities at Village level, the study on post-weaning economy and overall cost of production per kg of pork was made restricting to 1st generation pigs of the three genetic groups both under Farm and Village Conditions. Twenty pigs of both sexes of the same age groups for each of Farm and Village conditions were selected to form the experimental stock in the study. The data on overall feed intake, gain in body weight and feed conversion ratio of Local, Hampshire and crossbred pigs were recorded and presented in Table-1.

The overall feed intake, body weight gain and feed conversion ratio under Farm condition were 157.9 kg, 31.25 kg and 5.05 kg in Local Pigs; 260.4 kg, 63.25 kg and 4.11 kg in Hampshire; 181.0 kg., 40.32 kg and 4.48 kg in Crossbred pigs, while the corresponding values under Village conditions were 124.0 kg., 26.3 kg. and 4.71 kg. in Local; 204.15 kg, 43.35 kg and 4.68 kg in Hampshire; 162.6 kg., 35.0 kg. and 4.64 kg in Crossbred pigs respectively.

The expenditure incurred on feed, labour, health cover, physical facilities and interest on fixed capital were the major items towards the cost of pork production.

Feed

In pig production feed is the major input constituting 70-75 per cent

Table-1: Overall feed intake, body weight gain and feed conversion ratio during the period of 8-32 weeks of age.

Genetic groups	Overall feed intake (kg.) per pig.	Overall gain in body weight(kg) per pig.	Feed conversion ratio
FARM CONDITION:			
Local	157.9	31.25	1:5.05
Hampshire	260.4	63.25	1:4.11
Crossbred	181.0	40.32	1:4.48
VILLAGE CONDITIONS:			
Local	124.0	26.3	1:4.71
Hampshire	204.15	43.55	1:4.68
Crossbred	162.6	35.0	1:4.64

of total cost of production. In the present study irrespective of conditions of rearing, it was also found that expenditure on feed was the major important item constituted between 51.40 and 70.94 percent towards gross cost of pork production (Table-2).

The present expenditure on feed was found to be the lowest in Local (51.40%) followed by Crossbred (53.89%) and Hampshire (56.10%) under Farm condition, while the corresponding orders under Village conditions were: Hampshire (67.04%), Crossbreds (69.65%) and Local (70.94%).

The difference in high per cent expenditure on feed under Village conditions were the result of break up of feed cost from the gross cost of production (Total expenditure). Further, the per cent expenditure on the other inputs were comparatively low under Village conditions, which attributed to enhancement of the expenditure on feed.

Labour:

Labour is the next important item constituting 15.42 to 23.59 per cent towards gross cost of per kg of pork production.

The per cent expenditure on labour in each genetic group of pigs was 23.59 and 20.47% in Local, 15.42 and 16.8% in Hampshire, 21.55 and 16.4% in Crossbred pigs under Farm and Village conditions respectively.

The variations in per cent expenditure on labour amongst the genetic groups were due to fluctuations in overall expenditure although the total expenditure on labour in terms of rupees remained same under Farm condition due to equal number of labours engaged to look after the animals irrespective of genetic groups, whereas the variation in per cent expenditure on labour under Village conditions was due to family and hired labourers engaged on consolidated remuneration for up keep of animals. Hence, there were variations in the expenditure on labour between Farm and Village conditions in all the three genetic groups.

Health cover:

The per cent expenditure on health cover were 1.4 and 3.25% in Local, 0.91 and 1.86% in Hampshire and 1.28 and 2.43% in Crossbred pigs respectively under Farm and Village conditions. The per cent expenditure on health cover has apparently less under Farm condition in comparison to Village conditions. The reasons for variations might be attributed to exposure of animals under extreme weather, poor sanitations, lack of proper housing for animals under Village conditions.

Physical facilities:

It was observed that there was a variation in per cent expenditure

Table-2: Estimation of expenditure on various Inputs under Farm and Village conditions in Local, Hampshire and Crossbred Pigs during the period of 8-32 weeks of age.

I N P U T S

Genetic groups	Feed (Rs)	Labour (Rs)	Health cover (Rs)	Physical facilities (Rs)	Interest on fixed (Rs)	Overall expenditure (Rs)
FARM CONDITIONS:						
Local	5491.20 (51.40)	2520.00 (23.59)	150.00 (1.40)	100.00 (0.93)	2420.00 (22.65)	10681.20
Hampshire	9166.08 (56.10)	2520.00 (15.42)	150.00 (0.91)	100.00 (0.61)	4400.00 (26.93)	16336.06
Crossbred	6300.00 (53.89)	2520.00 (21.55)	150.00 (1.28)	100.00 (0.85)	2620.00 (22.41)	11690.00
VILLAGE CONDITIONS:						
Local	4364.80 (70.94)	1260.00 (20.47)	200.00 (3.25)	50.00 (0.81)	278.00 (4.51)	6152.80
Hampshire	7180.00 (67.04)	1800.00 (16.8)	200.00 (1.86)	100.00 (0.93)	1430.00 (13.35)	10710.00
Crossbred	5723.92 (69.65)	1350.00 (16.4)	200.00 (2.43)	75.00 (0.91)	880.00 (10.69)	8228.80

(Figures in the parenthesis are percentage to total cost)

Table-3: Cost of production per kilogram of pork for Local, Hampshire and Crossbred Pigs under Farm and Village conditions.

Genetic groups	Local		Hampshire		Crossbred	
	Farm Condi- tion	Village condi- tion	Farm Condi- tion	Village condi- tion	Farm condi- tion	Village condi- tion
No. of animals	20	20	20	20	20	20
Average body weight at slaughter	43.0	33.86	68.0	58.0	54.0	44.0
Average dressed weight (kg)	27.0	24.85	47.3	40.0	40.0	34.0
Average dressing percentage	62.79	73.4	69.55	68.96	74.07	77.27
Average of total pork produced (kg)	540.0	497.0	946.0	800.0	800.0	680.0
Average total expenditure (Rs)	10,681.00	6,152.80	16,336.00	10,710.00	11,690.00	8,228.52
Cost for kg of pork (Rs)	19.77	12.37	17.26	13.38	14.61	12.10

on physical facilities between the groups of pigs under Farm and Village conditions. The per cent expenditure on physical facilities under Farm and Village conditions were 0.93 and 0.81% in Local, 0.61 and 0.93% in Hampshire, 0.85 and 0.75% in Crossbred pigs respectively. There was no significant difference on per cent expenditure on physical facilities between the genetic groups under Farm and Village conditions.

Interest on fixed capital:

The expenditure on per cent interest on fixed capital was found to be higher under Farm condition when compared with that of Village conditions. The per cent expenditure under Farm and Village conditions were 22.65 and 4.51% in Local, 26.93 and 13.35% in Hampshire, 22.41 and 10.69% in Crossbred pigs respectively. The higher per cent expenditure on interest on fixed capital under Farm condition were due to high capital expenditure involved in the construction of pig sties of permanent nature, cost of animals and other associated facilities mentioned elsewhere, whereas under Village conditions, total expenditure involved for construction of pig sheds with locally available materials and other facilities were considerably less. Accordingly, the interest on fixed capital on housing which was calculated on the basis of floor space occupied by the pigs reared for the study under Farm condition and interest on other associated facilities were higher than that of the interest on these items under Village.

It could be observed that total expenditure involved on pork production during the period of 8-32 weeks of age under Farm and Village conditions were Rs 10,681.00 and Rs 6,152.80 in Local; Rs 16,336.00 and Rs 10,710.00 in Hampshire; Rs 11,690.00 and Rs 8,228.52 in Cross bred pigs respectively.

It was further observed that total pork production (Table-3) at 32 weeks of age of 20 pigs each under Farm and Village conditions were 540 kg and 497 kg in Local, 946 kg and 800 kg in Hampshire; 800 kg and 680 kg in Crossbred pigs respectively.

On the basis of the findings the average cost of production per kg. of pork under Farm and Village conditions were calculated as Rs 19.77 and Rs 12.37 in Local; Rs 17.26 and Rs 13.38 in Hampshire; Rs 14.61 and Rs 12.10 in Crossbred pigs respectively. The production cost per kg of pork was found to be lower under the Village conditions in all the three genetic groups of pigs, when compared with Farm condition. The high cost of production of pork under Farm condition might be attributed by the high cost of feed, labour, interest on fixed capital, physical facilities in an established pig Farm than that incurred under Village conditions.

INDIGENOUS VETERINARY MEDICINES FOR PIGS

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Technical Consultant, INDIAN HERBS

BANGALORE, (INDIA)

The use of Ayurvedic Veterinary Medicines was in vogue in ancient times for eg. as old as Ashoka period (250 B.C.) and Harshavardhana time (750 A.D), there existed a chain of Veterinary Hospitals in the country. In the famous universities of Takshila and Nalanda, foreign students used to come to study medical and veterinary ayurved. It may be noted that more than 80% of the population of our country still relies on the old system in some form or other and on the indigenous medicines for animal treatment because of cultural tradition and low buying capacity. When we take into consideration this economy factor with centuries of proven efficacy, the indigenous veterinary drugs, otherwise known as Herbal Veterinary Drugs is the only choice for millions of our farmers. The use of indigenous drugs will therefore help us in providing the much needed health cover to the maximum number of animals particularly in the rural and remote areas of the country.

Literature available since ancient times is replete with convincing evidence that herbai medicines were efficacious in treating various ailments of the livestock without producing any side effects. Based on this knowhow, M/s Indian Herbs, Pioneers in research and manufacture of Ayurvedic Veterinary Drugs on scientific lines, were successful in introducing a range of veterinary products of proven efficacy at moderate prices. These products have undergone extensive clinical trials, Pharmacological and Toxicological studies, etc., with the collaboration of eminent veterinary scientists all over the country and the results achieved have proved the efficacy of the products without any toxic effect.

Pig farming, which was being practised in the past, by the so called untouchables namely by people belonging to the schedule caste and schedule tribes in a very unhygienic manner has now assumed the status of modern pig industry run by government organisations and by people belonging to both forward and backward communities because of its economic importance and the availability of knowledge on modern scientific management, breeding, feeding, healthcare and marketing about pig farming. Just as other species of livestock, pigs are also susceptible to a variety of disease problems and the effective control of the same is necessary for successful pig farming. Pigs are susceptible to various virus diseases such as Swine Pox, Hog cholera (Swine Fever), African

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Extensive field trials and research have shown that herbal anthelmintics and tapeworm infestations in livestock and poultry. Further, the herbal anthelmintics do not cause adverse side-effects. Secondly, diseases due to various ectoparasites in animals is a very common problem affecting the health and production of the affected animals. Numerous experiments conducted have conclusively shown that external application of HIMAX ointment, spraying with PESTOBAN and oral administration of TEEBURB, all herbal products of INDIAN HERBS have been found to be reliable and effective remedies in the treatment of various types of skin troubles, without causing any side effect. Sharma HN et.al (1981) at College of Veterinary Science, Guahati carried out clinical trials or HIMAX in the treatment of wounds due to gangrenous tail in 19 and surgical wounds in 6 pigs and observed taht all the cases got cured within 6-10 days.

Satija K.C. at Veterinary Clinics, Haryana Agricultural University, Hissar successfully treated 24 clinical cases of pigs suffering from sarcoptic mange with 3 to 4% solution of PESTOBAN. All the affected pigs were microscopically as well as clinically got cured within 20 days of treatment and no toxic effect due to pestoban was noticed.

Sudden drop in the milk yield in lactating cows and buffaloes due to various causes is a serious economic loss for the owners. Scientists have reported that the use of hormonal Galactogogues and additives for the increase in milk yield is not satisfactory in as much as, the result is only transitory lasting for a short period only and also cause serious side effects. GALOG a herbal product, which has undergone extensive clinical trials and research has been found to be effective in maximising milk yield in cows and buffaloes suffering from hypogalactia due to various causes, by stimulating lactiferous tissues without any side effect at all, increase in the milk yield persisting throughout the lactation even after stoppage of treatment, with no change in the composition of milk, better utilisation of the absorbed ingredients by the glands not requiring additional feed and above all promoting smooth let down of milk due to oxytocic like effect also. As the treatment is only for short duration for 15-20 days the cost of the treatment is negligible particularly in a sow and GALOG would ensure that all her suckling piglets get adequate milk

for them to survive and attain optimum growth.

HIMALAYAN BATISA, a renowned digestive, appetite stimulant and general tonic is being used by the livestock owners for the past three decades with utmost satisfaction. HIMALAYAN BATISA improves motility of alimentary tract and helps in the proper digestion. TIMPOL another herbal product is found very effective in promoting expulsion of gas and preventing further formation of gas in the alimentary tract.

NEBLON by its astringent, effective absorbent and stool binding properties, is found to be a reliable anti-diarrhoeal drug. Soni J.L. et.al (1980) at College of Veterinary Science and Animal Husbandry, Jabalpur successfully carried out treatment trials with NEBLON in 196 Large White Yorkshire pigs suffering from non specific diarrhoea. They found 63.26% responded in one day, 17.34% in 2 days and the rest in 3-6 days with complete recovery.

CAFLON is an efficient expectorant offering comprehensive therapy for cough in Pigs.

LIVOL has been proved to be a very good liver tonic for livestock for superior growth and efficient feed conversion. LIVOL also helps in counteracting the effects of aflatoxins that might have been ingested by the pigs through fungal contaminated feed and thus would ensure optimum performance in the pigs. LIVOL can be used in pig farming as a growth promoter.

STATUS OF PIGGERY DEVELOPMENT IN INDIA WITH SPECIAL REFERENCE TO BIHAR

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In India, pig farming is a subsidiary occupation mainly of the socio-economically poor farmers. They rear the common village pigs (indigenous) which has no definite characteristics. It is a small size animal having a slow growth rate and poor litter size as compared to exotic breeds. According to the 1982 provisional census there were about 10 million pigs in the country, of these Bihar alone had 1.05 million pigs. According to the National Commission on Agriculture, 1976 about 0.72 million tonnes of meat is produced in India, of which only 7 per cent comes from pigs. The demand for meat in the country by the turn of the century has been estimated to be 1.6-2.1 million tonnes against 0.72 million tonnes produced in 1976. This necessitates taking up of essential and urgent steps to boost pig production.

In view of protein deficient food problem of our country it is essential to improve the productivity of all meat producing animals and multiply them. Pig can play a very important role in increasing meat production because of their short generation interval, high prolificacy, efficiency of feed conversion, faster growth and higher dressing percentage.

Very little attention was given to piggery development up to the second Five-year plan. The Government of India initiated a comprehensive piggery development programme in 1959-60 towards the end of the second Five-year plan. During the third plan, pig Breeding stations with Bacon Factory, Pig Breeding Farm and piggery Development Blocks were established in several states including Bihar at selected centres. Some exotic breeds of pigs like Landrace, Large White Yorkshire, Tamworth, Hampshire etc. were introduced at different pig breeding/multiplication centres. AICRP on pigs were taken up by the ICAR during the fourth plan and they started functioning from 1971 at four Research Centres viz, Assam Agricultural University, Guwahati, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Indian Veterinary Research Institute, Izatnagar and

A.P.A.U., Tirupati involving Landrace and Large White Yorkshire pigs. In the second phase, the ICAR decided to exploit native germ plasm (Desi pigs). AICRP on pigs were completely remodelled. The indigenous pigs hence become the base and research work is conducted in the first instance on the indigenous pigs and subsequently on the crossbreds which are produced by crossing indigenous gilts to the boars of the appropriate exotic breeds.

Pig breeding is very popular among tribals in the Chotanagpur belt and also among the weaker sections of society in other parts of Bihar. Therefore, pigs are mostly concentrated in Chotanagpur plateau region and certain other areas like Purnea, Saharsa, Darbhanga, Chapra, Motihari. Gradually, with the genetic improvement of pigs and greater economic return from pig rearing, some well-to-do persons of the society have also started taking interest in pig rearing.

The farmers under integrated rural development programme have been benefitted by rearing the pure as well as crossbred pigs of improved variety. Earlier the pig breeders of Chotanagpur liked only Desi pigs. But after distribution of improved variety of pigs under various extension education programmes they now want to rear only improved variety of pigs. The demand for improved variety of pigs is thus increasing day by day and we are not in a position to fulfil their demands. For this we need about 50 to 60 thousand crossbred piglets annually for the whole of Bihar.

Breeding Policy

Since indigenous pigs have very poor economic traits, these pigs have to be upgraded by crossing from exotic animals. For this purpose, pigs are being imported from Australia, UK, USA and Ireland for pig breeding farms in Assam, Bihar, West Bengal, Kerala, Karnataka, Nagaland, Arunachal Pradesh, Andhra Pradesh, etc. It is estimated that pig breeding farms are maintaining about 10,000 exotic pigs alongwith their progenies (Landrace, Large White Yorkshire, Hampshire, Saddleback etc.). Pig rearing and pork consumption are popular practices, particularly with the tribals in the North-Eastern States and Bihar and also in certain other pockets like Goa, Daman and Madhya Pradesh. Pig rearing in these areas have to be followed intensively.

Feeding and Managing Practices

Pig meat is considered a low quality meat as compared to other meat in India. Therefore, it sells at low prices. Hence, the cost of production of pork has to be kept low. About 70-75 per cent cost of the pig production is contributed towards feeding. Considering these aspects, various State Governments and Central Government are trying to evolve low cost feeds. Usually, in villages and in urban areas, pigs are kept

on by-products of grain industry and hotel wastes and on grazing. However, in Government, breeding farms, pigs are maintained on nutritive ration as these pigs are distributed for breeding purposes. Housing for pigs have also to be managed economically. Therefore, farmers keep pigs in thatched kutcha house. On Government breeding farms, well equipped pucca pig sheds are available.

Piggery Schemes

Many development schemes are running under Birsa Agricultural University, Animal Husbandry Department to improve the economic and the socio-economic conditions of the Adivasis and weaker sections of the society.

Piggery unit of Ranchi Veterinary College supply the weaned piglets to the villagers under following programme:

1. Lab to Land Programme:-

Lab to Land Programme sponsored by I.C.A.R. started in Birsa Agricultural University from 1980-81. There is provision of Rs.600/- in the form of kind which includes cost of piglets, feed, cement etc. having a unit of one male and two weaned piglets, as a non refundable help under this scheme. the farmers are given practical training at their door regarding breeding, feeding management and health control. Pig specialists in various discipline go to the farmers door from time to time.

2. Extension education programme:-

Under this programme we are assessing the various phenotypic and genetic parameters of pigs distributed to farmers. Generally cross-bred weaned piglets are being distributed in the villages so, their adaptability, performance and nutritive requirements are assessed. This will help in producing an improved pigs to be raised by the farmers of the tribal belt by adopting suitable breeding plan.

The scheme run by Animal Husbandry Department are:-

1. Fattener's scheme

In this scheme, weaned piglets are distributed at subsidy rate. In MESO area a sum of Rs.5.00 per piglets is charged from the breeders and in non-MESO area, Rs.10.00. A feed subsidy is provided at the rate of Rs.15.00 per month per piglet for six months. When the piglets are fattened, they are purchased by Bacon Factory at the rate fixed by the Government.

2. Extending facilities to pig breeders

The department provides the pig breeders 3 sows at the rate of Rs.50/- each and a boar is given free of cost. A subsidy of Rs.150.00 is given for the construction of house for the pigs.

3. Grading up scheme

Boars only are provided for the grading up of local pigs with the exotic boars. A subsidy of Rs.10.00 is given against feeding cost to maintain the boars in a good and healthy condition.

4. Intensive piggery development projects

There are 6 IPDP in Bihar viz. Lohardaga, Simdega, Katihar, Chakradharpur, Dumka and Purnea. IPDP Purnea comes under special component scheme of 20-point programme.

5. Special Animal Husbandry Programme

In this scheme, pigs in a ratio of 3:1, 2:1 is provided to the breeders. 50% of subsidy is provided against the cost of pigs by Government. In specified areas Nationalised banks provide the financial help. The pigs are distributed in the piggery Development Blocks. There are provisions to meet the cost of the housing, feed for the pigs.

6. I.R.D.P.

In this scheme, entire Bihar is covered. Distribution of pigs are done in the ratio of 3:1 or 2:1 in all the 885 blocks of the state to people under poverty line. The scheme runs with the collaboration of Nationalised banks. A subsidy of 50% is provided to Adivasis and Harijans and 33%, 25% subsidy to small farmers and marginal farmers respectively.

MANAGEMENT OF PIGS WITH GARBAGE AS ECONOMIC FEED DURING SCARCITY PERIOD

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Under good managerial condition and mechanised farming, feed is the most important crisis faced by the pig breeders irrespective of private or Government. If the pig feed is good and give all the nutrient requirements to pigs, pig farming he has to see the sources of good ration. There is a stiff competition for maize grains which constitute the major energy feed ingredient in the pig ration from the human population. Similarly, the prices of fish meal and Ground Nut/Til oil cakes are also beyond the purchasing power of the ordinary farmer. Even the quality of all the ingredients of pig ration is very difficult to control throughout the season. Inorder to avoid such problems and for economic rearing, Kitchen wastes/Garbage can be given to pigs as feeds. It is more practicable in those areas where hotels, restaurants, student hostels and military canteens/messes are available.

Recently, in the year 1986 an attempt to see the growth performance of pigs and cost of production on garbage feeding had been made in the College of Veterinary Science, Assam under the following experimental schedule:-

Groups	Number of pigs		(Hampshire) Total	Average body wt. (kg)	Feeding regimes
	Male	Female			
I	3	3	6	8.583 ± 0.757	Conc. Ration.
II	3	3	6	9.083 ± 0.300	75% conc.+25% cooked garbage.
III	3	3	6	8.833 ± 0.543	50% conc.+50% cooked garbage.

The chemical composition of the cooked hostel garbage and normal

concentrate pig ration for the experiment was as follows:-

Constituents	Garbage(%) (Average of 13 samples)	Normal Concentrate ration (%) (Average of 5 samples)
Moisture	85.00	10.00
Crude Protein	13.07	18.12
Crude fibre	2.13	5.21
Ether Extract	5.96	3.82
Total Ash	6.98	8.60

After 91 days of experiment, the following observation was made.

Groups	Total body wt. gain (kg)	Statistical Analysis On body wt. gain	Cost of production per Kilogram of live weight gain
I	13.417 $\pm$ 0.352	Not Significant	Rs.13.51.
II	14.917 $\pm$ 1.076		Rs.13.37.
III	15.583 $\pm$ 0.768		Rs.11.48.

It may therefore be suggested that to minimise the cost of feed in rearing commercial pigs, a ration could be substituted upto 50 percent level by Garbage without any adverse effect. However, if similar experiments on Garbage alone upto slaughter age along with the study of carcass characteristics be carried out, it would throw more light in the safer and economic use of Garbage in Commercial Pig Farming.

EMBRYO TRANSFER IN SOWS

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Application of the technique of artificial insemination in pig Industry has provided a considerable opportunity for genetic improvement of the herd. In particular, the availability of methods for freezing of semen has facilitated the extensive use of choosen boars. In contrast, effective exploitation of genetic potential of the sow is not yet possible, and achievement of this objective by means of embryo transfer must wait for the development of techniques for the storage and non-surgical transfer of embryos. In recent years, economic pressure has caused considerable changes in the choice of the breeds of pigs. The breed should not be allowed to disappear merely because they are of no current economic importance. A method of low temperature preservation of embryos and its non surgical transfer in sows would offer an extremely convenient method for conservation of rare breeds. It would be helpful in developing a convenient and cheaper method for import and export of breeds.

Effective technique for embryo transplantation were first developed in the early 1960s and since then they have been applied mainly in research. The objectives and prospects of embryo transfer in pigs are to increase rare blood lines rapidly to obtain more offsprings from genetically superior sows. Prevention of disease transmission is a most important aspect of modern pig husbandry and embryo transportation would provide the safest method of introducing new genetic material into closed herds.

Embryo transfer is the successful fixing of the fertilized egg - the blastocyst to the uterine wall where it grows on into an embryo, and then into a foetus and finally into an expelled live piglet. It involves superovulation of the donor, embryo recovery, manipulation of embryos, synchronization of both donor and recipient sows and technique of transfer.

Superovulation of donor

Normally a gilt produces between 12-18 and a sow between 16-28 eggs. Fewer eggs can only result in fewer piglets. The basic idea of superovulation is to get more number of matured eggs from the sows. For superovulation a dose of 100-1500 I.U. Pregnant mare's serum gonadotrophin (PMSG) given early in the follicular phase (day 15 or 16 of the oestrous cycle) usually produces 25-30 ovulations in mature gilts. Heat normally occurs 3.5-4 days after PMSG treatment but 500 I.U. Human Chorio Gonadotrophin (HCG) is given during the third day after PMSG treatment will synchronize the time of ovulation in a group of animals.

The donor sow is bred artificially two or three times with increased number of spermatozoa.

Collection of embryo

The tortuous nature of the cervix and uterus in the pig virtually precludes the collection of embryos from the uterus by non-surgical means. In surgical approach, a mid-ventral laparotomy is performed under general anaesthesia and the reproductive tract is exposed. A fine glass cannula is inserted into the isthmus through a small hole made in the tip of the uterine horn. Flushing fluid passed down the oviduct from the fimbriated end is collected via the cannula into a petridish. The medium commonly used for embryo collection is Dulbecco's phosphate buffered saline enriched with lactate, pyruvate and bovine serum albumin. The embryos are collected 4-8 days after the onset of oestrous.

Isolation and classification of embryos

The embryos are examined under binocular/dissecting microscope. The morphological and chronological examination of embryo are interesting from the point of view of the efficiency of fertilization and optimal pregnancy rate and litter size. The eggs are classified as unfertilized if they have single cell or fragmenting and contained no sperm in the zona pellucida.

Culture and preservation of embryos

Pregnancy rates from transferred embryos tend to fall after storage more than one hour, after collection. The phosphate buffered saline medium is quite satisfactory for temporary storage, but is less suitable for the storage of hatched blastocysts. A modified Kreb's Ringer Bicarbonate Medium is also suitable for culture of 4 cell embryos into blastocysts.

The long term storage of swine embryos by freezing is not yet feasible. Despite the inability to freeze pig embryos, some successful long distance transportation of embryos have been achieved. In an experiment, embryos were transported in culture medium from the USA to England and transferred to recipients within 20-27 hours after collection from donors. Seven of the 12 recipients farrowed producing 58 piglets from 227 transferred embryos.

Heat Synchronization of Donor and Recipient

The success of embryo transfer depends on the synchronization of oestrous between recipient and donor sows. A simpler and more effective method of oestrous synchronization is the treatment on any day of the oestrous cycle with a dose of 15-20 mg altrenogest per pig per day for a period of 18 days. The withdrawal of the compound spontaneous rebound to follicular activity. The sow shows the symptoms of heat on the fifth

or sixth days of withdrawal of treatment.

Technique of embryo transfer

Non-surgical transfer of embryos is not successful. For surgical transfer of fertilized ova mid ventral laparotomy of the recipient animal is performed. After exposure of the reproductive tract, embryos can be transferred either to the oviduct or uterus depending on the stage of embryonic development. The embryos are picked up in about 0.2 ml of fluid in a fine Pasteur pipette which is threaded down the lumen via the fimbria to a depth of about 5 cm. For transferring embryos to the uterus, a small puncture is made in the isthmus region of the oviduct about 2 cm from the tip of the horn and tip of the pipette is slid down into the uterine lumen through the utero tubal junction.

Possible future developments.

Embryo transfer offers real possibilities of research in pig production by producing identical genotypes, thereby reducing the cost of the experiments. The sexing of embryos will prove a powerful tool in the advancement of the breeding programme which will help in obtaining births of more number of females. Recent developments in embryo transfer technology would be advantageous in increasing genetically improved meat type sows within a short period of time.

DISEASES OF SWINE COMMUNICABLE TO MAN

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Global importance of zoonoses and their major impact on the health and economy of many people has been recognised now. Many zoonoses are transmitted to man from swines via pork, other products and wastes which are now having greater contact with man. A list of diseases of swines communicable to man are being presented in the following table:-

Disease	Aetiological Agent	Usual Methods of Human Infection
VIRUS DISEASES		
Foot and mouth disease	Virus	Contact and milk
Vesicular stomatitis	Virus	Method uncertain
Influenza	Virus	Contact
Rabies	Virus	Animal bite
Murray Valley encephalitis	Virus	Mosquito-bite
Western encephalitis	Virus	Mosquito-bite
BACTERIAL DISEASES		
Anthrax	Bacillus anthracis	Contact
Brucellosis	Brucella suis] Brucella melitensis] Brucella abortus]	Contact and through milk
Haemorrhagic septicaemia	Pasteurella multocida	Animal bite, contact
Leptospirosis (Swineherds' disease)	Leptospira sp.	Skin abrasions, contact
Pseudotuberculosis	Pasteurella pseudotuberculosis	Method uncertain
Salmonella (Food poisoning)	Salmonella sp.	Ingestion
Swine-erysipelas	Erysipelothrix insidiosa	Skin abrasions

Disease	Aetiological Agent	Usual Methods of Human Infection
Tuberculosis	Bovine type] Human-type] Avian-type]	Contact or ingestion
Gas gangrene	Clostridium sp.	Through skin
Listeriosis	Listeria monocytogenes	Uncertain
Melioidosis	Pseudomonas sp.	Mosquito-bite
Tularaemia	Pasteurella tularensis	Contact, ingestion and insect
FUNGUS DISEASES		
Actinomycosis	Actinomyces bovis	Method in doubt
Aspergillosis	Aspergilli sp.	Inhalation of spores
Ringworm	Trichophyton mentagrophytes	Contact
Histoplasmosis	Histoplasma capsulatum	Inhalation and ingestion
Nocardiosis	Nocardia sp.	Contact
Coccidioidomycosis	Coccidioides immitis	Inhalation, wounds
Cryptococcosis	Cryptococcus neoformans	Inhalation, ingestion
PROTOZOAN DISEASES		
Balantidiasis	Balantidium coli	Ingestion
Trypanosomiasis (African)	Tr. Gambiense and] Tr. rhodesiense]	Tsetse fly bite
Amoebiasis	Entamoeba polecki	Ingestion
NEMATODE DISEASES		
Gongylonimiasis	Gongylonema pulchrum	Ingestion
Metastrongyliasis	Metastrongylus elongatus	Ingestion
Trichinosis	Trichinella spiralis	Under-cooked pork
Ascariasis	Ascaris lumbricoides(suum)	Ingestion
CESTODE DISEASES		
Hydatid disease	Echinococcus granulosus	Ingestion
Pork tape worm infection	Taenia solium	Under-cooked pork

Disease	Aetiological Agent	Usual Methods of Human Infection
TREMATODE DISEASES		
Fasciolopsis infection	Fasciolopsis buski	Raw plant food
Gastrodiscoides infection	Gastrodiscoides hominis	Contaminated food
Lung-fluke disease	Paragonimus westermani	Eating cray fish and crabs
Opisthorchiasis	Opisthorchis viverrini	Eating raw-fish
Gnathostomiasis	Gnathostoma hispidum	Eating infected fish
ARTHROPOD DISEASES		
Dermatitis	Tunga penetrans	Contact

A number of successes have been achieved in zoonoses control in many countries in the recent past. However, in many parts of the world especially the developing countries adequate attention is yet to be paid to the growing problem of zoonoses.

PROFESSIONAL SERVICES FOR FOOD PROCESSING

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The implementation of a food processing project is not simple.

Union International Consultants (UIC) have been in the business of providing professional services for food processing for well over 60 years and they are associated with a large worldwide group of operations through their parent company which ensures that not only feasibility, engineering design work and project management can be adequately covered, but also the training of clients' management teams together with commissioning and ongoing management.

They are not a normal consultancy. They are a company that is involved with the day-to-day management decisions and requirements of ongoing process plant and are integrated with the commercial considerations of raw meat material supply and produce sale. They can advise clients of the correct size and technical contents of a factory from feasibility study through to completion and ongoing management. What they design, they are prepared to manage and the usual inadequate interface between consulting engineer and client management is always bridged.

As can be seen they are experienced in food processing consultancy covering virtually all aspects of the subject. However, their past experience has concentrated mainly upon the Meat Industry, covering both red and white meat. A wealth of experience has also been acquired in vegetable processing, together with cold storage and refrigeration systems. On the red meat side, they have an impressive track record covering projects involving stock surveys, stock breeding and fattening systems and red meat processing plant, together with meat industry by-products covering the Leather Industry, all forms of canning, stock feed, tallow, margarine plants and soap production and detergents factories. On poultry, UIC have a long history involved with determining the requirements for hatcheries, growing farms, processing plant, rendering facilities and milling plant for the preparation of feed for the growing farms.

Many years have been involved in determining the best technology for taking in vegetables for washing and grading, blanching, continuous freezing, and then the provision of bulk storage arrangements. Their service goes on to providing facilities for vegetable packaging and distribution.



NATIONAL AGRICULTURAL SURVEYS
FOOD PROCESSING PLANT AND
DISTRIBUTION FEASIBILITY STUDIES
PROCESS PLANT LAYOUTS
FOOD PLANT DESIGNS
DRAWINGS/SPECIFICATIONS
TENDER DOCUMENTATION
TENDER EVALUATION
CONTRACTS
PROJECT MANAGEMENT
MANAGEMENT TRAINING
COMMISSIONING
MANAGEMENT CONTRACTS



COLD STORAGE
MEAT PLANTS
POULTRY PROCESSING
VEGETABLE PROCESSING
MEAT, VEG. & FRUIT CANNING
SOAP & DETERGENT PRODUCTION
MARGARINE
ICE CREAM PLANTS
MEAT RETAIL DEPOTS
TANNING/FELLMONGERIES
RENDERING PLANTS



Union International Consultants

Design and Management Consultants to the Food Industry

14 West Smithfield, London EC1A 9JN Telephone 01-248 1212 Telegrams Widespread Telex 883291/3 Wedde G Fax 01-236 7627

Union International Consultants have been working worldwide for many years. They are actively involved in Australia, New Zealand, South America, Europe, the Middle East, Africa, Asia and the Far East. They believe that the expertise they have is second to none in the field of food processing engineering and management. Their worldwide day-to-day involvement ensures that the latest techniques developing continuously in many parts of the world are continuously at their fingertips and available to their many clients.

Food Processing and Control

Implementing a food processing project is complicated and it is essential if the project is to be a success that competent professional services are employed so that a commercial plant is built which is of the right capacity to service the raw material supply and, more importantly, produce the products that the consumer wants. If these factors have been satisfactorily concluded, then the project, once operational, should be profitable.

The first consideration of any project concerns the production of a feasibility report. Such a study must analyse the supply of raw materials for the processing factory, whether it be a vegetable processing unit, a meat factory or other such food processing establishment. It is obviously no good building a plant of such a size to reap the benefits of low unit costs if the raw material supply is limited and of too high a cost. Therefore, one of the most important aspects of the initial feasibility study must be to estimate the raw material available and its price and quality, and relate these considerations to the design of the plant. The study could take the form of a national survey or, alternatively, a study of the areas local to the proposed factory site.

Within the feasibility study, the other aspect of prime importance is to determine the type of products that the client should produce, having studied the market for the finished products, and whether the plant is to service the local community or whether exports should be considered, or possibly a combination of the two.

With a good survey to cover raw material supply and market demand for specific products completed, a sizing of the plant can be achieved from which a budget price can be estimated. In this initial development of the plans of the plant, and assignment of manning requirements, service costs and all other product costs must be built up and this of course requires an assessment of the local scene to determine the various economic rates for these variables.

The feasibility study would have established the concept size and budget cost of the factory. The next stage concerns the establishment of detailed process layouts and it could well be that several alternative

plans are developed with the substitution of labour for machinery and vice versa, and depending upon the economy of the country, the client and the investment funds available the final choice will be made on the process configuration. .

After the process layout has been frozen together with a revised budget price, detailed engineering can start and this involves the production of engineering drawings and specifications to cover the building works, refrigeration, mechanical and electrical services, effluent treatment requirements and process equipment. the professional consultant chosen will build up the drawings and documents necessary to obtain competitive bids from local and international contractors. Once this stage is completed, the consultant will then be involved with the assessment and analysis of the tenders received from which he can make the final recommendations to the client as to which combination of contractors should be chosen to carry out the project to achieve the optimum commercial realisation. The completion of all this design phase work will be of no avail unless competent project management is introduced to ensure that the contractors selected build the project to the standards required, and that the contractors are co-ordinated so that construction and machinery installation follows a scientific plan.

During the construction of the operation, it is essential that local management be suitably trained to ensure that once the plant is ultimately commissioned, it will be competently managed. Once the mechanical and building works are terminated one of the most difficult parts of any project is production commissioning and it is essential to have a programme of gradual purchase of raw materials so that product rates are built up over a period of several months while the sales department puts their original plan into operation to sell the production produced. In developing countries where clients are entering new fields, it is usual to employ professional ongoing management services to ensure that this vital stage of the operation is carried out effectively so that the cash flow and profit and loss forecasts are achieved in practice. This training and management phase of projects is the one which is so often overlooked and which is essential to achieve any possible success.

MEAT EATING AND HEALTH

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Inspite of the availability and abundant supply of nutrients provided by meat and other animal products, meat has frequently been attacked by vegetarian groups and even by nutritionists, in the light of possible health related problems. It has been alleged to be associated with the development of carcinoma, cardiovascular disease and hypertension.

Animal fats (lipids) in the diet have come under attack as causing heart disease for three reasons; (i) because of the quantity of fat in the diet, (ii) because animal fats contain a relatively larger proportion of saturated fatty acids than vegetable fats, and hence have been claimed to be atheriogenic and (iii) because animal fats have more cholesterol than vegetable oils, which are also claimed to be atheriogenic. Atherosclerosis is the underlying cause of coronary heart disease. Cholesterol, phospholipids, fats, iron and proteins are deposited within the inner lining of the blood vessel walls. These compounds form a mass (atheroma) that protrudes into the opening of blood vessels, and later calcium may be deposited in the atheroma, causing hardening of arteries or a disease called atherosclerosis. Cholesterol has been established as a key precursor of the steroid hormones. Approximately 80 percent of cholesterol metabolized is transformed into various bile acids. Liver also synthesizes cholesterol. Exogenous cholesterol intake from animal fats was at first thought to be responsible for the genesis of atherosclerosis, but this theory has been proved erroneous. It has been proved that cholesterol alone does not cause heart disease. Medical and nutritional scientists have proved that increased incidence of atherosclerosis appears to parallel prosperity. Heredity, obesity, physical inactivity, hypertension, too many cocktails, excessive smoking and other socioeconomic factors appear to be related to heart disease.

Meat and meat products consumption are not responsible for deaths from cancer. Although the consumption of meat has been increased during the last 40 years, it does not significantly increased the incidence of cancer. There is some evidence that increased consumption of meat, with concomitant alterations in other dietary constituents, and increased gut transit time, may play a role in the development of carcinoma of large intestine. Scientists have proved that colon cancer is a disease of affluence and stomach cancer is a disease of poverty. Epidemiological observations have suggested that there is an association between high

calorie, high fat and low fibre diets with colon cancer, but meat consumption does not appear to be involved other than through its contribution to obesity.

A relationship between salt intake and hypertension has been recognised for many years. Hypertension has been shown to be associated with obesity with a decrease in blood pressure being achieved by weight reduction. It does not appear that meat alone has any major effect on hypertension. However, consumption of cured meat containing large amount of salts should be minimised.

Current evidence, suggests that the flesh foods are not directly involved in the production of diseases. Although there is still controversy on the role of saturated versus unsaturated fatty acids of cholesterol from animal products in relation to coronary disease. It is not recommended a drastic change in eating habits for consumers as a whole, except for high risk cardiovascular patients who are under the care of a physician. The best advice appear to be prevention of obesity by maintaining a proper balance between caloric intake and energy expenditure so as to control body weight.

CHAPTER III

ORGANIZATION AND INFRASTRUCTURE OF TODAY'S PIG INDUSTRY

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3.1 The Enterprise and the Infrastructure

There are some prerequisites to a thriving Pig Industry viz a favourable climate; an abundance of balanced and cheap feed; human population within the region that is skilled in and temperamentally adapted to handle the Pig enterprise; and finally, adequate market. Before taking the task of pig enterprise, a careful survey of its resources should be made. It will ascertain the availability of various factors which are essential for a pig enterprise including capital, land, feed, labour, equipment etc. Some of the requirements for the successful pig production are as follows:-

3.1.1 Character of the Farm

There are certain conditions present in the farm itself influencing its suitability for pig production. It must have all the capability of producing an abundance of concentrates. Good quality legume hay may be produced in the farm. The farm must also provide an opportunity to rotate the pastures as an essential step in the control of parasites. The condition of soil also helps for pig farming, although it is not essential to a good pig farm. Well drained land with respect to both surface and under drainage is highly desirable. Natural shade and running water are the essential requirements. The size of the swine enterprise can be adapted to the facilities that almost any farm provides. The land which is untillable can be used for non-productive purpose like construction of sheds, store house, roads and other buildings. A farm that possesses the other requisites including all weather roads and the suitable market nearby will be successful.

3.1.2 Ownership of the land

The operator's ownership is desirable for successful pig farming. However, the product life cycle of pig farming is small and requires a small capital outlay and a little equipments.

3.1.3 The Capital Investment

The capital investment essential for a satisfactory swine enterprise

is small in proportion to the sales from the enterprise. The capital investment plays an important role in limiting the cost of production. On most pig farms, the tendency is to keep capital investment low and consistent with good management practices. The reduction on the investment in breeding animals may reduce their productivity, the quality of the offspring and ultimately returns from the enterprise. It is desirable to use good quality infrastructure to decrease death losses, feed waste and labour costs.

3.1.4 Equipment

The equipment plays an important role in pig farming due to the influence of the nature and arrangement to save on feed, saving of labour and the satisfaction derived from the enterprise. On an average, the building and equipment cost account for 5 to 10 per cent of the total cost of producing pork. The function of equipment is to protect the animals and feed and to expedite the work of caring for them. To achieve high success, it is essential to equip fully with equipment, skill in planning individual places as well as their arrangement and utilisation.

3.1.5 Feed and land requirements

Feed is the greatest single item in the cost of producing pork accounting to about 70 to 75 percent of the total cost. The pigs are unable to utilise considerable amount of roughage. Therefore, cost and development of pig farming is governed by the supply of concentrates at cheaper rates.

3.1.6 Labour

The good organisation and management of the pig enterprise reduces the labour cost. Small enterprise requires higher labour cost than large ones. The nature and usefulness of the equipment provided may also influence the amount of labour required to care for pigs. The introduction of self-feeder, adaptation of modern equipment reduces the labour by more than half. In a well managed farm, the labour cost account for 6 to 10 per cent of the total cost of producing pigs. Proper arrangement in buildings, the layout of roads and the use of pastures are important factors in keeping labour costs low. The distribution of labour in pig farming is fairly uniform except during the farrowing time. Additional labour is required during farrowing season but it does not interfere seriously with the other farm work. The quality rather than the quantity of the labour available is important.

3.1.7 Skill of the operator

The skill of the farm manager is important, especially during the adverse business conditions like labour strikes etc. The burden of

the manager is proportional to the size of the farm.

3.1.8 Maintenance of the Farm Records

Good records are absolutely essential for the successful operation of pig farming. Proper maintenance of records will reveal the weakness of the operation, and indicate the course to develop the enterprise in the direction of profit. In recent times, record keeping has become simple. These records can be prepared or purchased. Maintenance of adequate records are essential for financial assistance from the banks or other financial institutes.

3.1.9 Marketing

A good market is essential for satisfactory marketing for the pork and pork products. Now a days the demand for pork and pork products is increasing. The establishment of Government Bacon Factories and private pork processing plants have contributed to the availability of the market for farmers. Prices of pigs are also influenced by seasons, in some season it is on higher side. Packers pay higher prices for hogs of certain weights than they do for others. Some packers pay higher prices for cross bred hogs of high quality. The grading standards used by various buyers are not the same. Through careful planning it is possible to prepare the kind and weight of hogs that will top in the market. Efficient marketing of the products is essential for higher returns.

3.2 Functions of Pig Enterprise

Profits in pig enterprise is the difference between the cost of production and the net sale receipts of the pork etc. It can be increased by reducing the cost of production or by raising the selling price of the pork and pork products with no change in the cost of production, or by simultaneously changing both factors on the directions indicated.

Most pig farmers are extremely sensitive to the selling price of their animals, but seldom know even approximately their cost of production. Variation in the cost of production have greater influence than variations in the selling price on the profits to be derived from a pig enterprise. Successful development and management of swine enterprise creates the need for understanding the nature and characteristics of pig industries.

- (i) Pig provides a market for feed and labour which are profitable. The pig is an efficient converter of the feeds which are not consumed by man into pork and pork products which have a high nutritional value in the human diet. Many grains and seeds that could be eaten by man are fed to swine because they are produced in abundance and because of

the pork and pork products they produce have a higher nutritional value and are more palatable than the grains. Pigs make excellent use of many by-products which are totally unsuited for human food such as tankage, meat scraps, various oil meals and hotel and kitchen wastes.

- (ii) Pig enterprise creates the profitable work for the available labour on the farm who otherwise might not have been employed. This business can be successfully combined with dairy or other farm activity.
- (iii) In areas, where pigs are well adapted yield a profit constantly than other class of livestock.
- (iv) The nature of pig affords two excellent qualities. Pigs are prolific and their reproductive cycle is short enough to permit quick increase in numbers.
- (v) In recent years, the pork production and demand for pork and pork products have increased in our contry. But its demand is lower than that for other meats. The decline in the relative popularity of pork is due to two factors. (1) increased competition from other meats, especially poultry and (2) the quality of pork that has been produced. The price competition is highly critical of excessively fat pork cuts, made serious inroads on pork consumption. It is costlier than beef. Beef has always been the preferred meat of the low income group.
- (vi) The pigs have the capacity to transform directly or indirectly the materials and energy contained in feeds into other forms more useful and desired by mankind. The condensing of feeds and other waste byproducts of lower weight but higher nutritional value represents a tremendous saving in freight in marketing the products of the farm.
- (vii) Pigs utilize certain byproducts feeds that have no direct value in the human diet and not particularly well adapted to the feeding of other classes of animals. Slaughter house waste, tankage and fishmeal can be successfully used.
- (viii) Pigs can utilize unsound and partly damaged feeds and grains which are rendered unmarketable.
- (ix) Pigs utilize the waste products very efficiently. Table garbage, bakery waste, unmarketable fruits and many other products can be fed to pigs.

- (x) Pigs may increase the efficiency of other enterprises like dairy farming by utilization of the surplus labour.
- (xi) Pigs aid in maintaining soil fertility. They produce the faeces with good manurial value.

3.3 Planning Pig Production

Planning is very important to set up pig production as a small enterprise to generate additional income. Many people have been attracted to pig production as an apparently simple means of making extra money but just as many have lost money and given up with disappointment. Before starting on investment in pigs it is essential to ensure that all aspects have been examined and that all the necessary links in the chain have been established.

The driving force in this enterprise is the market. It is essential to establish a market for pig meat, and it will pay a good amount of profit. The market is of course not fixed. It often happens that an initially small market can be expanded by producers who consistently make available reliable supplies of an attractive product, competitively priced. In this way the enterprise can expand its own market. The questions required to be asked are:-

- where is the demand for pork ?
- for what kind of product ?
- how big is the demand ?
- is it regular ?
- is it being satisfied at present ?
- can it be expanded ?
- what price is being paid ?

The answers to these questions will give you some idea about how many pigs you might expect to sell and at what price. You might find, for example, that there was a competitive trade in fresh pork but unsatisfied demand for some specialized pig products such as ham, sausages. It would be more profitable to establish in one of these markets rather than trying to compete with established producers in an already stabilised market.

The size of the unit may be decided by physical limitations the land available for buildings, the amount of feed that can be obtained, the problems of waste disposal and so on or it may be decided by the desired output which may simply be the farmer's own requirement about the expected sales in the locality. Increasing the size requires more

capital investment which may mean borrowing more money or losing the income for which the pigs are being kept. It also brings income risk of the possible collapse of the market and increases the problems of management and health control which always tend to be greater problem in the large unit. A bigger unit also requires more and more of the farmer's time and energy.

3.4 Characteristics of Pigs and their production

Pigs produce pork that differs from the flesh of all other animals in texture, flavour and certain nutritive properties. Because of the nature of their diet and their extraordinary rapid growth rate, they are extremely sensitive to unfavourable rations and to careless management. A person who desires to start pig farm and to make the best out of his pig enterprise must become acquainted with the natural characteristics of swine and provide conditions that will permit them to function to their maximum capacity.

- (i) Pigs can utilize concentrates well and are efficient producers of human food. They convert small grains into pork and pork products very efficiently by utilizing rations which differ greatly in nature. They produce more live weight gain from a given weight of feed than any other class of meat animals.
- (ii) Large acreages of land in our country are for one reason or another untillable and it can be utilized for pig farming.
- (iii) It may be pointed out that in old civilizations not inhibited by taboos against the consumption of meat or other animal products but great population pressure has developed against food supply. The survival of pigs in India appears to be largely due to their ability as scavengers rather than to extraordinary efficiency they possess as converters of nutrients into human food.
- (iv) Pigs were prized originally in this country because of their ability to store fat rapidly and their early improvement emphasized their capacity for this purpose. But now the trend has been changed and there is a demand for lean pig meat.
- (v) Pigs are prolific and bring quick returns. These grow rapidly, mature quickly and are prolific as they produce more number of pigs at birth can be managed to raise two litters in a year. Gilts may be bred at the age of about 8 months, far when approximately a year old, and their pigs will weigh more than 90 kg by the time they are 6 months old.

- (vi) The pig enterprise is flexible and farmer can increase the size of his operations as promise of increased profit appears. He may buy feeder pigs or he may manage the pigs of a bred which produces two litters per year. A reduction in the size of the enterprise may be achieved as desired. This very flexibility, is advantageous specially for the price fluctuations in the market and prevents the possible loss.
- (vii) The pig enterprise requires moderate investment than other enterprise.
- (viii) Pigs can be sold well at a wider range of weights. Slaughter prices are regularly quoted on all weights, from 50 kg to 150 kg. The wide weight range over which hogs may be sold to advantage permits considerable choice at the time of marketing the crop of pigs. If the price is not satisfactory at a given time, the pigs can be held for a higher market.

3.5 Factors which effect cost of Production

There are a number of factors which support their production as a vigorous industry. As a safeguard against disappointment and perhaps even failure, preparatory consideration should extend to the actual problems that will be met in starting and maintaining a farm.

3.5.1 Number reduce costs

The intensive production in this industry has been made possible by the ingenuity of swine growers in devising and adapting new equipment and methods of handling sows during the farrowing season, so that the operator can now successfully handle more number of sows and litters. The increase in size of operation, usually increases profits. The economics of size of pig producing farms in India are maximum when farms reach about 30-45 sows. It is important to emphasize that the combination of size and superior management will lead to reduced cost of production.

3.5.2 Major or Minor enterprise

On many farms that provide the requisite physical requirements, as outlined earlier, swine production is a major enterprise and regularly serves as a principal source of income. Under other conditions it functions equally well as a minor enterprise. The greatest success in pig farming comes only with the experience. It is well to begin with small numbers and increase the size of the operations gradually as the adaptability of the farm and one's own ability as an operator are revealed by profits from the enterprise. As a minor enterprise swine production can be made to supplement several different enterprises. The size and nature of herd vary with conditions. It may consist of several brood sows which are

maintained to produce the desired pigs, or the required number of pigs may be purchased as feeders.

3.5.3 Purpose of the Herd

The great majority of pigs are raised for the purpose of producing pork, though a smaller number are maintained primarily as a source of improved breeding stock. The sale of pigs which are to be used for breeding purposes has traditionally been restricted to purebred herds and Government Pig Breeding farms. The competition demands that breeder should develop intelligent programmes that will keep their herds highly productive for commercially important characters including high carcass quality. The breeding of animals requires special skill not possessed by every one, and how well they are sold may even be the determining factor in the success of the entire enterprise. A purebred requires a greater investment than a grade herd and is more expensive to maintain.

3.6 Small scale versus Commercial Pig Production

The small scale pig farmer has no chance of keeping pigs as efficiently as can be done in a large unit. The large commercial farmer has some advantages, he can carry a greater number of breeding stock and make more effective genetic selection, he can buy his requirements in large quantities and at lower prices, he can achieve economics of scale in the use of labour and other inputs. However, the small farmer has advantages of his own. He can probably build the house cheaply with his own labour, members of the family can help in the work in free hours; the wastes and by-products from the house and farm, from neighbours and local industries can form an important part of the feed requirement; less chances of major disease problem; and dung and urine are a valuable resource rather than a nuisance.

The small farmer is at greatest advantage in the use of locally available feeds. The various often wet and bulky materials are available to small scale production units because they are difficult to handle mechanically and not easy to incorporate in compound feed. The big unit requires a large, regular and reliable supply of its feed ingredients. The cost of production of small farmers is lower and can accept a slow rate of growth.

3.7 Advantages and problems of Pig keeping

The pigs are primarily maintained for meat production. The main advantages of pig keeping are:

- (i) Pigs are more efficient converters of crops into meat than other animals.
- (ii) Pigs do not require specific crops. They can thrive on a great variety of plant material including roots, stems, leaves and seeds.

- (iii) Pigs can utilize by-products and waste from household, farm or industry which might be thrown away.
- (iv) The pigs are prolific breeders and can produce more than 1.6 litters per year.
- (v) Pigs do not require a large capital investment but they do provide quick returns on investment.
- (vi) Pigs require a little space.
- (vii) All parts of the carcasses are useful.

There are some drawbacks of pig farming.

- (i) Pigs are competitors for some items of human food.
- (ii) Pig meat is not universally liked; muslims in particular do not eat it.
- (iii) Pigs can cause pollution and nuisance - smell, flies and noise.

CHAPTER IV

S T A T I S T I C S

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Reliable statistics is a pre-requisite for planning effective developmental programme. With limited financial and physical resources, statistics at Village, District, State and all India level is essential to take up proper policy decisions. It also gives the basic data about the production for unit of commodity for formulating the sound pricing policy.

However, very little data is available on pig industry. The available information is presented in the following pages, which will be helpful in calculating the feasibility of the economics of pig production and providing guidelines for improving the method of pig production.

For formulating effective pig developmental programmes for different areas it is necessary to have information on regional changes in the size and composition of pig population. Table 4.1 gives State wise pig population in India, based on quinquennial Livestock Census conducted by State Governments and supervised by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

As per the estimates made by Food and Agriculture Organisation, Rome, the Indian pig meat forms 7.5 per cent of the total meat production. Although, estimates of meat production using sample survey technique is being attempted through a Centrally Sponsored Scheme. But these estimates would be available after some time. Table 4.2 gives meat production in India based on FAO production Year Book.

The World pig meat constitutes 38.92 per cent of the total meat production. Table 4.3 shows the total meat production in the World, Developing and Developed countries. In India pig meat constitutes 7.5 percent against 38.92 percent in the World. This shows high potential and scope for the development of Indian pig industry.

It is essential to achieve maximum production standards to establish pig production as an economic enterprise. The suggested production standard for breeding and feeding stock are shown in Table 4.4 and 4.5 respectively. These data are based on research findings in U.K. and not be applicable under our conditions, but would be useful in giving a broad idea of production standards.

Table 4.1 : Pig Population in India

(in thousand)

State	1966	<u>All India Livestock Census</u>		1982
		1972	1977	
Andhra Pradesh	582	690	755	786
Assam	264	330	514	578
Bihar	646	879	946	1043
Gujarat	2	8	34	172
Haryana	100	143	203	250
Himachal Pradesh	3	3	5	8
Jammu & Kashmir	@	1	5	8
Karnataka	207	280	296	319
Kerala	112	129	173	127
Madhya Pradesh	378	343	361	474
Maharashtra	181	203	226	302
Manipur	74	134	134	368
Meghalaya	108	127	152	207
Nagaland	111	184	238	248
Orissa	180	387	295	418
Punjab	45	38	124	226
Rajasthan	83	117	130	180
Sikkim	-	-	19	30
Tamil Nadu	475	584	678	694
Tripura	37	44	45	103
Uttar Pradesh	1162	1302	1606	2282
West Bengal	143	378	362	768
Union Territories	142	152	372	486
All India	5035	6456	7673	10072

@ Less than 500

Table 4.2 : Meat Production in India.

Type of Meat	(Thousand Tonnes)			
	1979-81 Average	1985	1986	1987
Beef & Buffaloe Meat	266	304	324	329
Sheep & Goat Meat	418	500	519	531
Pig Meat	70	86	87	90
Poultry Meat	111	161	175	138
Total Meat	965	1167	1221	1208

Source: FAO Production Year Book - 1987.

Table 4.3 : Meat Production in the World.

Item	(Million Tonnes)			
	1985	1986	1987*	1988**
WORLD TOTAL	150.7	154.5	156.9	158.5
Bovine meat	47.9	48.7	48.6	48.3
Sheep & Goat meat	8.3	8.4	8.5	8.6
Pig meat	59.3	60.0	61.0	61.5
Poultry meat	31.5	33.0	35.0	36.3
Other meat	3.7	3.8	3.8	3.8
DEVELOPING COUNTRIES	55.2	57.2	75.9	58.5
Bovine meat	14.4	14.5	14.5	15.0
Sheep & Goat meat	4.6	4.7	4.8	4.8
Pig meat	23.7	24.9	25.0	24.7
Poultry meat	10.5	11.0	11.5	11.9
Other meat	2.0	2.1	2.1	2.1
DEVELOPED COUNTRIES	95.5	97.3	99.0	100.0
Bovine meat	33.5	34.2	34.1	33.3
Sheep & Goat meat	3.7	3.7	3.7	3.8
Pig meat	35.6	35.7	36.0	36.8
Poultry meat	21.0	22.0	23.5	24.4
Other meat	1.7	1.7	1.7	1.7

* Preliminary figure; ** Forecast figure.

Source: Asian Livestock, May 1988

Table 4.4 : Suggested Production Standards for Breeding Stock.

	Poor	Average	Good	Best
Live pigs born per litter	9.6	10.3	11.0	11.5
Weaners per litter	8.3	8.9	9.5	10.5
Weaning at less than 3 weeks				
Litters per sow a year	2.15	2.30	2.45	2.50
Weaners per sow a year	18	20	22	24
Feed used per weaner (8 wks) 88 kg		76 kg	68 kg	63 kg
Feed used per weaner(25 kg) 105 kg		94 kg	83 kg	77 kg
Weaning at 3 and 4 weeks				
Litters per sow a year	2.05	2.20	2.35	2.40
Weaners per sow a year	17.5	19.5	21.5	23
Feed used per weaner(8 wks) 90 kg		80 kg	70 kg	65 kg
Feed used per weaner(25 kg) 107 kg		96 kg	85 kg	79 kg
Weaning at 5 and 6 weeks				
Litters per sow a year	1.85	2.00	2.15	2.20
Weaners per sow a year	16	18	20	22
Feed used per weaner(8 wks) 95 kg		85 kg	75 kg	70 kg
Feed used per weaner(25 kg) 112 kg		101 kg	90 kg	84 kg
Weaning at 7 and 8 weeks				
Litters per sow a year	1.65	1.80	1.95	2.00
Weaners per sow a year	14	16	18	20
Feed used per weaner(8 wks) 105 kg		95 kg	85 kg	80 kg
Feed used per weaner(25 kg) 122 kg		111 kg	100 kg	94 kg

Statistics on economics of pig production have gained importance in recent years. The productivity of the pig depends on mortality and growth rate which is associated with feed conversion efficiency. Since, nutritional and other environmental condition vary greatly within the country, the performance of pigs to fit all situations cannot be realistically found. The research work conducted at various centres of All India Coordinated Research Project on Pigs is presented in Table 4.6 to 4.8. Table 4.6 shows the average birth weight, reproductive performance

Table 4.5 : Suggested Production Standards for Feeding Stock.

	Poor	Average	Good	Best
From 8 weeks of age(18 kg)				
Mortality rate	3.5%	2.3%	1%	0%
Feed conversion rate				
Porkers (67 kg lwt)	3.5	3.15	2.8	2.5
Cutters (86 kg lwt)	3.8	3.4	3.1	2.9
Baconers (90 kg lwt)	3.8	3.4	3.1	2.9
Heavies (117 kg lwt)	4.2	4.0	3.7	3.6
Quantity of feed per pig	kg	kg	kg	kg
Porkers	172	155	137	123
Cutters	266	235	217	203
Baconers	277	250	226	212
Heavies	420	400	370	360
From 25 kg liveweight				
Mortality rate	2.5%	1.4%	0.5%	0%
Feed conversion rate				
Porkers (67 kg lwt)	3.6	3.25	2.9	2.6
Cutters (86 kg lwt)	3.9	3.55	3.2	3.0
Baconers (90 kg lwt)	3.9	3.55	3.2	3.0
Heavies (117 kg lwt)	4.3	4.15	3.8	3.7
Quantity of feed per pig	kg	kg	kg	kg
Porkers	151	135	122	109
Cutters	246	215	202	189
Baconers	257	230	211	198
Heavies	400	380	353	344

and carcass characteristics of exotic pigs maintained at Izatnagar, Khanapara, Jabalpur and Tirupati. Table 4.7 shows the carcass characteristics of barrows slaughtered at Khanapara, Izatnagar and Tirupati. The dressing percentage ranged from 65.48 to 79.38 per cent. The average backfat thickness varied between 1.84 and 3.13. Table 4.8 shows the efficiency

Table 4.6 : Average birth weight, reproductive and carcass characteristics of exotic pigs at Centres of All India Coordinated Research Project on Pigs.

Trait	Sex	Landrace Izatnagar	Hampshire Khanapara	Large white Yorkshire	
				Jabalpur	Tirupati
Birth weight	Male	1.37	1.27	1.28	1.28
	Female	1.35	1.23	1.25	1.25
Weaning weight	Male	11.47	11.10	11.62	11.31
	Female	11.39	11.08	11.41	11.41
Litter size at birth	-	8.31	8.16	8.96	8.38
Litter size at weaning	-	6.97	7.52	8.26	7.96
Litter weight at birth	-	11.11	10.17	11.31	10.45
Litter weight at weaning	-	74.60	79.86	20.25	83.33
Carcass weight	-	55.90	52.84	56.84	59.06

XIth Workshop of All India Coordinated Research Project on Pigs at Jawahar Lal Nehru Krishi Vishwa Vidhyalaya, Jabalpur - January 23-24, 1989.

Table 4.7 : Carcass Characteristics of Barrows (Crossbred Pigs)slaughtered at Centres of All India Coordinated Research Project on Pigs.*

Traits	Khanapara	Izatnagar	Tirupati
Live Wt (Kg.)	46.94	63.13	57.60
Hot Carcass Wt. (Kg)	30.76	41.76	45.25
Dressing Percentage (%)	65.48	-	79.38
Loin (Kg.)	7.77	-	12.75
Ham (Kg.)	7.12	9.32	10.25
Shoulder (Kg.)	8.51	5.80	5.97
Carcass Length (cm)	56.41	66.95	63.00
Backfat Thickness (cm)	1.84	2.79	3.13

Table 4.8 : Efficiency of feed utilisation (Gain in weight : feed consumed) in Crossbred barrows at centres of All India Coordinated Research Project on Pigs.*

Age (Weeks)	Jabalpur	Tirupati	
		I Farrowing	II Farrowing
8-12	1:8.9	1:5.51	1:2.65
12-16	1:7.8	1:4.54	1:7.27
16-20	1:5.8	1:5.54	1:4.19
Overall	1:6.52	1:5.10	1:4.46

* XI Workshop of All India Coordinated Research Project on Pigs at Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur, January 23 & 24, 1989.

Table 4.9 : Price of Pork & Pork Products in March 1989.

Name of the Product	(Rate in Rs./Kg.)			
	Central Dairy Farm, Aligarh		MAFCO, Bombay	
	EX-CDF	Ex Branches	Whole-sale	Retail
Pork leg with skin	22.00	24.00	-	-
Pork loin with skin	23.00	25.00	-	-
Pork leg without skin	23.00	25.00	-	-
Pork loin without skin	23.00	25.00	-	-
Pork Chops without skin	24.00	26.00	-	-
Pork without bone & fat	22.00	24.00	-	-
Under Cut	30.00	32.00	-	-
Pork Sausages	20.00	22.00	27.10	29.91
Cocktail Sausages	22.00	24.00	28.97	33.65
Smoked Ham	30.00	32.00	28.00	32.00
Back Bacon	38.00	40.00	32.00	36.00
Streaky Bacon	30.00	32.00	28.00	31.00
Salami	32.00	34.00	28.78	35.52
Frank Furter	31.00	33.00	31.78	35.52
Meat Pie	30.00	32.00	-	-
Pork Kabab	30.00	32.00	33.90	37.40

of feed utilization in crossbred barrows at Jabalpur and Tirupati.

The Government Bacon factories produces hygienic pork and pork products. They have adopted a price policy for sale of pork and pork products which is linked with the purchase price of the pigs. The price of pork and pork products varies greatly in different parts of the country. Table 4.9 shows the prices of pork and pork products of Government Bacon Factory, Central Dairy Farm, Aligarh and MAFCO Bacon Factory, Bombay.

CHAPTER V

HOUSING AND MANAGEMENT

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Pigs are by nature prolific breeder and economic and efficient converter of feeds into meat. Local strains of pigs are mostly raised by socio-economically backward and tribal people. Large scale pig farms are very few and most people rear them in small numbers except nomadic breeders who maintains a herd of 20-200 numbers. They neither provide them any shelter nor any conventional feed. Those who rear in their houses provide some kinds of shelter so called 'house' but no conventional feed are given. The efforts are being made to develop viable technology for the Indian pig industry through research.

Scientific system of raising on pattern to be recommended to our farmers must have relevance to the most practical approach of the local needs, using the cheaper and locally available housing materials. Pigs are raised mainly under two systems.

1. Scavenging system

The traditional pig keepers belonging to socio-economically backward class of the society are compelled to follow old and primitive method of pig rearing. Under scavenging system pigs are allowed to loose and fed on scavenging materials. This results in poor growth, high susceptibility to diseases, low litter size at birth and at weaning, low feed conversion efficiency and poor quality of pork and pork products. It does not require effort in management and practically no expenditure involves on food.

2. Outdoor system

Out door system are an attempt of pigs rearing in a modified way of scavenging system, Pigs are generally kept in a strong enclosures either made of wood or strong fencing materials. This system requires a large area for free movement of pigs. Small wooden houses are also provided within the enclosures for shelter. Pigs are allowed for rotational grazing and small quantity of balanced ration are provided. No systematic breeding is practised and sow for farrowing are shifted to a movable farrowing pen. Pigs reared under this system helps in increasing the fertility of the soil due to their habit of digging soil and passing excreta.

3. Confinement or Indoor system

This system of pig rearing has gained popularity and based on scientific know how. The pigs are housed in a small area hence expenditure on labour, health cover, and other physical facilities are greatly reduced. The efficiency of feeding and management results in production of quality pork and pork products. The systematic breeding programme helps in developing better progenies in the farm.

5.1 Housing

5.1.1 Fundamental needs

The gradual changes in the methods of rearing have made the people to realise the need for good housing system for increasing the profit. The commercial pig production with exotic breed is being promoted in our country. It has increased the need for adequate and cheap housing. The pigs are highly susceptible to climatic stress. The heat regulating ability of new born piglets is very poor, and as a result, mortality increases in preweaned piglets due to extreme change in weather. Housing can help in providing good management for production of high quality pigs.

5.1.2 The basic principles & requirements of Housing

The pig is a warm blooded animal. Its body temperature is 38.9°C. It has no sweat glands. The young piglets are poorly endowed with hairs, skin and subcutaneous fat and very susceptible to cold, damp and draught. The greater part of the energy is converted into heat, faeces and urine. The utilisation of energy in the production of heat can be minimised only through good housing. The most economical way to help pigs to maintain a heat balance is to give them free access to shade all through the day.

Desirable temperature for pigs of different ages and weight are as follows:-

0 - 1 Week	25 - 30°C.
1 - 5 weeks	22 - 27°C.
5 - 8 weeks	19 - 24°C.
Less than 50 kg	18 - 24°C.
More than 50 kg	15 - 24°C.

Other factors like climatic condition, humidity, air velocity influences on the heat tolerance of the animals. Temperature exceeding 30-35°C for exotic and crossbred pigs would reduce feed conversion efficiency in growing and finishing pigs and reproductive performance in breeding animals.

5.1.3 Types of pigsties under confinement system

There are three types of pig sties generally constructed for housing of different classes of animals:

- i) Grower's/Finishers pens.: Growing/finishing pigs (20-90 kg liveweight) for higher daily gain, better feed conversion and parasitic control.
- ii) Farrowing pens: For farrowing and lactating sows to reduce preweaning mortality and for higher quality weaners.
- iii) Gestating sows to allow individual feeding and better control of stock.

5.1.4 Location

A good location for a pig unit should meet the following requirements i.e., road communication and transportation reliable water supply, well managed under ground drainage system and sufficient distance from residential areas so as to avoid nuisance from odour and flies. The site of the building should be planned to give protection from the sun and exposure to wind. An east-west orientation is usually preferable to minimise exposure to sun. A fairly light, more or less self draining soil is always preferable and usually the higher part of a site should be selected for construction. Main supplies of electricity should be available. The site should be chosen with care as it plays an important role in determining the success of the new project.

5.1.5 Types of construction

A building for open confinement is essentially a roof carried on poles or pillars. In some cases it is preferable to give gable walls on one side protection from winds. These walls can be built temporarily from straw bales and is removed during hot weather to allow maximum aeration. Permanent walls must be provided with large openings to ensure sufficient air circulation in hot weather. An open building for fattening pigs includes a central feeding alley and manure alleys along the outside walls. The 1.20 metre wall around the building serves to reduce heat reflected from the surrounding ground. Ceiling fans may be provided for air movement among the pigs.

The main purpose of the house is to provide shade and therefore the radiant heat from the sun should be reduced. The most effective way of reducing the intensity of solar radiation by painting the roof with white paint. Plant materials such as hay, thatch, straward and other grabes are excellent material for roofing on hot climates. An adequate roofing is necessary to protect the pigs from rain, sun and cold. A barrier

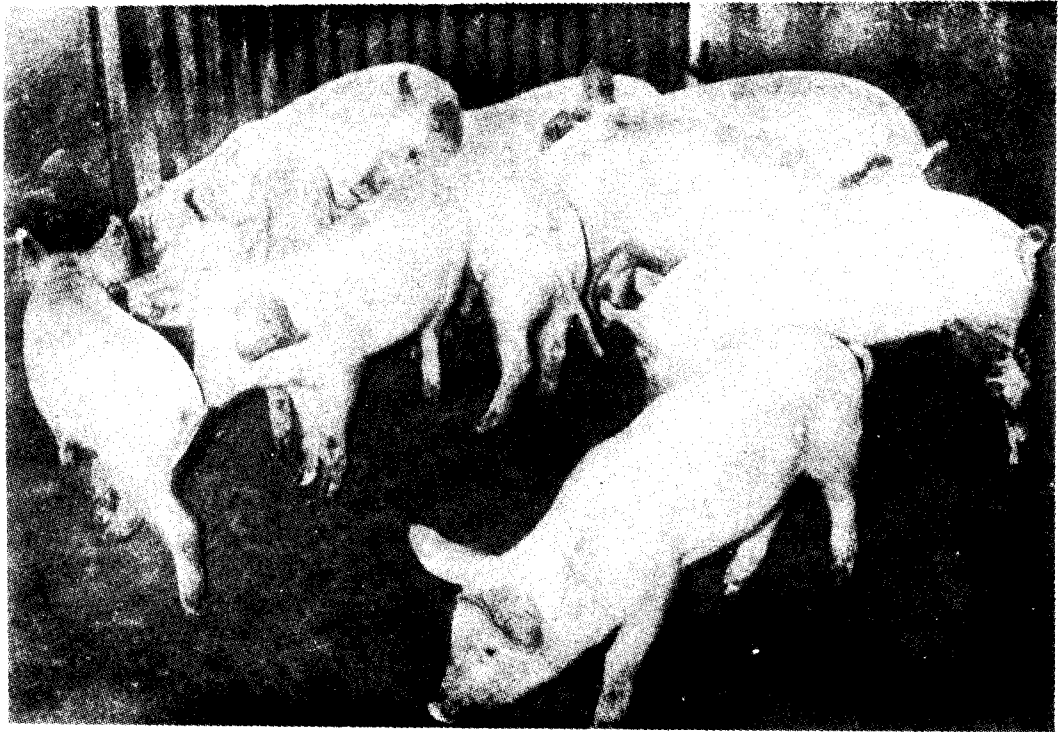
running along the side walls is useful to prevent rats entering the building. Corrugated iron sheets and asbestos sheets are good, permanent roofing materials. Corrugated iron sheets should have a inner roof of light timber. This is necessary to prevent secondary heating of animals produced by the roofing material. This can be done with locally available materials such as leaves, straw and bamboos etc. But these materials should be covered with wire net to protect it from birds and rodents.

Regardless of the type of house, construction should provide strength, resistance, warm and dry conditions. The pigs have powerful biting jaws and strong snout. Buildings and fencing must therefore be constructed in such a way that the pigs cannot either pull them down or root them out. Materials like stone, bricks, concretes are suitable for construction of pig houses. The walls of the building should preferably be cement plastered to form smooth cleanable surfaces. Concrete floors are the best and most durable, easy to clean, non-absorbent and not slippery if rough finished. Cement floors should be finished with non-porous and it should provide a reasonable grip. Floors can be solid, semi slatted or fully slatted. Normally one layer of concrete about 100 mm thick, on a consolidated gravel base, is sufficient to give a good floor. Concrete proportioned 3:2:1 or 4:2.25:1 (Gravel:Sand:Cement) is commonly used. The floor is divided into sections of 3 X 5 or 4 X 4 meters, according to the building plans. Slatted floors are widely used in intensive pig houses. The slatted floors makes the cleaning easier since a lot of manure is pushed through the slots. It also reduces the chances of spread of disease and helps to maintain comparatively a cooler environment so that more number of pigs can be housed. Slats can be made of timber, concrete or plastic. Timber slats should be made from quality, non-splintering hardwood.

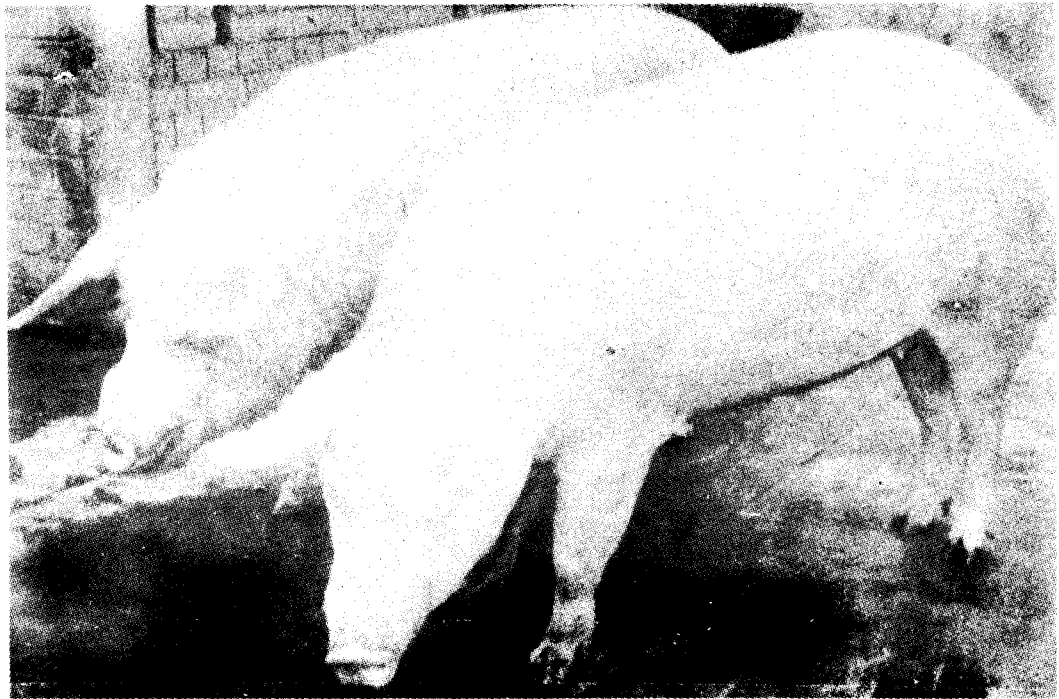
5.1.6 Space requirements and pen layout

The requirement of floor area per pig varies depending upon the size of animals and prevailing climate of the area. It also depends on whether they are kept on solid or slatted floors. Pigs on solid floors requires a greater area. The table below gives guidelines for the space to be allowed for each condition.

Pig weight(kg)	Area per Pig (m ²)		Area per Pig (ft ²)	
	Solid	slatted	Solid	slatted
4-11	0.37	0.25	4.00	2.7
11-18	0.56	0.28	6.00	3.0
18-45	0.74	0.37	8.00	4.0
45-68	0.93	0.55	10.0	6.0
68-95	1.11	0.74	12.0	8.0



Healthy Stock of Young Piglets



Farrowing Pen	1.52 x 2.13m (5 ft x 7 ft)
Sow stall	0.56m wide x 1.67m to 2.13m long. (1 ft 10 inch x 5 ft 6 inch to 7 ft) depending on the size of the sow.

The requirement of spaces are given in terms of length and breadth of pens and varies greatly depending on the building plan. There must be sufficient space for feeding trough to ensure that all the pigs in the pen get adequate quantity of feed. The space requirement of feeding trough of pigs are shown below:-

Pigs weight (kg)	Trough space per pig	
	(mm)	(inch)
11-18	150	6
18-45	250	10
45-68	290	12
68-95	330	13
Sows	350	14

The above figures indicate space needed for individual feeding. For group feeding each feeding space is allowed for every 3 - 4 pigs with pens accomodating up to 20 pigs and each space per 4-5 pigs with pens of over 20 pigs.

5.1.7 Housing for different stages of Production

- (a) **Farrowing house:** Special pen layouts are required for farrowing sows. The aim of farrowing pen design is to provide comfort for the sow and as a measure of safety, warmth and free access to food for the piglets. A farrowing crate or a set of guard rails are an aid in saving small pigs. The rails should have enough space to allow the sow to lie down comfortably and to expose both row of teats. Infrared heat lamps are the best source of brooding heat. The heat lamps can be arranged in one corner of the pen. The alternative plans are shown in Fig. 5.1.7.1. In section A, the farrowing pens are 2.40 m x 2.70 meters with a 1.6 meter alley. These pens have guard rails 25 cm above floor level and 25 cm from the pen wall to protect piglets from being crushed. At weaning sow can be taken out and the piglets left for another one or two weeks for avoiding weaning stress of the piglets. In section B at farrowing the sows are put in stalls 60-70 cm wide depending upon the size of the sow. After few days the stalls can be removed or opened up to allow free movement of the sow. For both the system it is advisable to provide some bedding materials such as

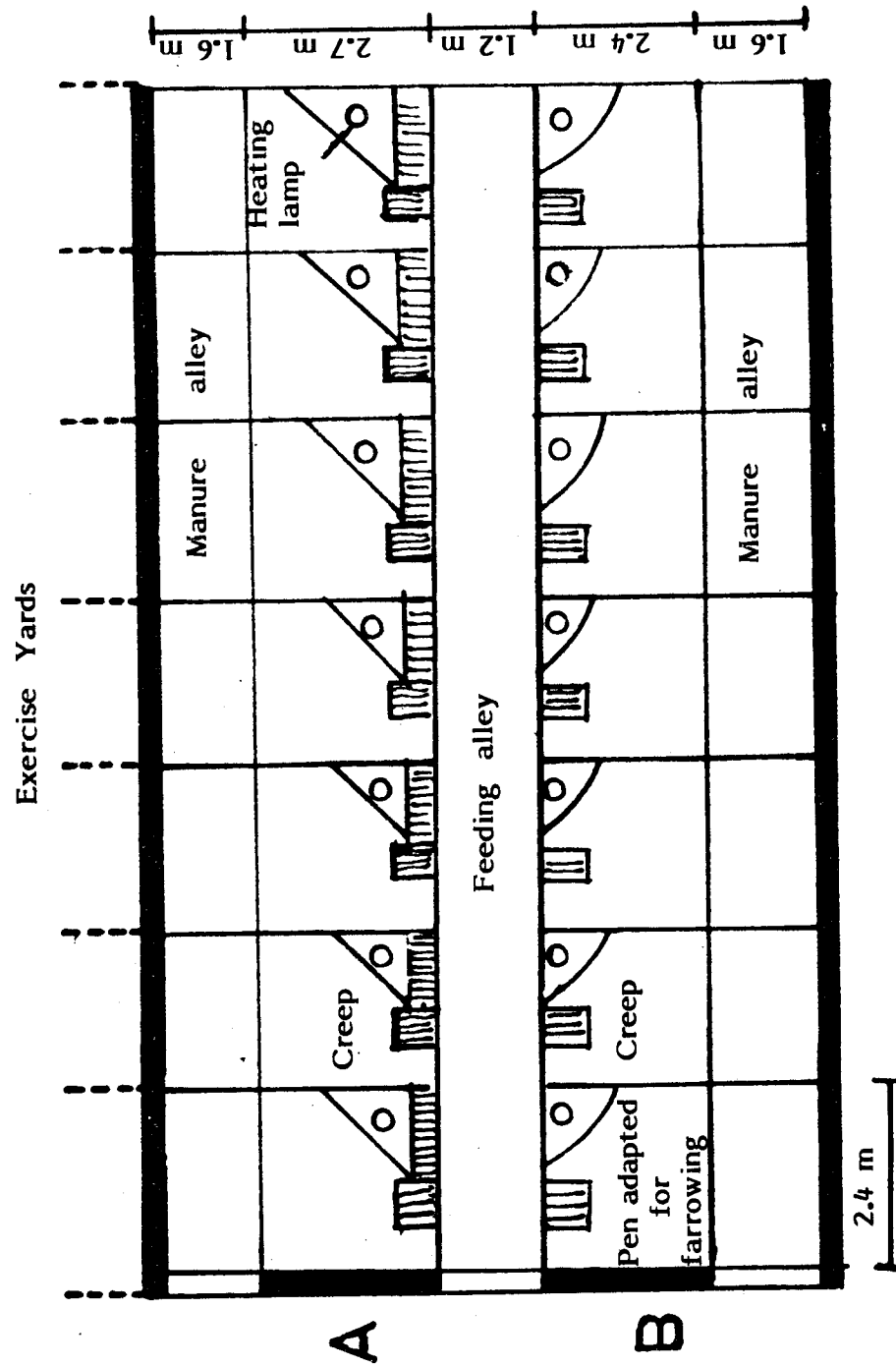


Fig. 5.1.7.1 Plan of Farrowing House.

straw to increase the comfort of animals.

- (b) **Housing for growing/finishing pigs:** In this system, a central feeding alley along with feeding troughs on each side of the passage, associated with pens of 3m x 1.80 meter deep are provided. These would accomodate:-

Upto	40 kg	15 pigs
40 -	90 kg	10 pigs
Over	90 kg	8 pigs

In summer months, it is preferable to reduce the number of pigs. Pen walls should be made of solid wood or concrete of about 60 cm height to prevent pigs from fighting between pens. Above this point tubular steel is preferable. Controlled feeding is important to ensure the best possible feed conversion efficiency and production of high quality pigs. Feeding trough should be made up of concrete or other resistant material. The trough can also be used for watering, but automatic device will ensure the constant supply of fresh water. Housing plan is shown in Fig. 5.1.7.2.

- (c) **Housing for gestating sows:** In this system of confinement housing the sows can be individually fed both during gestation and immediately after weaning in order to improve the reproductive performance. Fig. 5.1.7.3 shows a layout for gestating sows grouped in pens containing 5 sows each. The number may vary according to size of the herd.
- (d) **Housing for Boars:** Boars may be housed separately in pens closed to the sows. Along the back of the pens there should be a fenced in area with a concrete floor for daily exercise. It is shown in Fig. 5.1.7.4.
- (e) **Combined housing:** For smaller units with less than 50 sows, specialised buildings for the various stages of production may not be practical or desirable. A universal pen 2 meter wide and 3 meter deep could be used for one sow with her litter or one boar or three to four gestating sows or six to seven growing/finishing pigs of up to 90 kg live weight. When used for farrowing, the pen should be provided with guard rails or a farrowing stall and creep with heating or a portable wooden crate for the piglets. Fig. 5.1.7.5 shows the outline of a combined housing plan. Combine housing provides a high degree of flexibility but does not prove as efficient use of building space in comparison to specialized units. The farrowing should be evenly distributed to manage the requirement of pens.

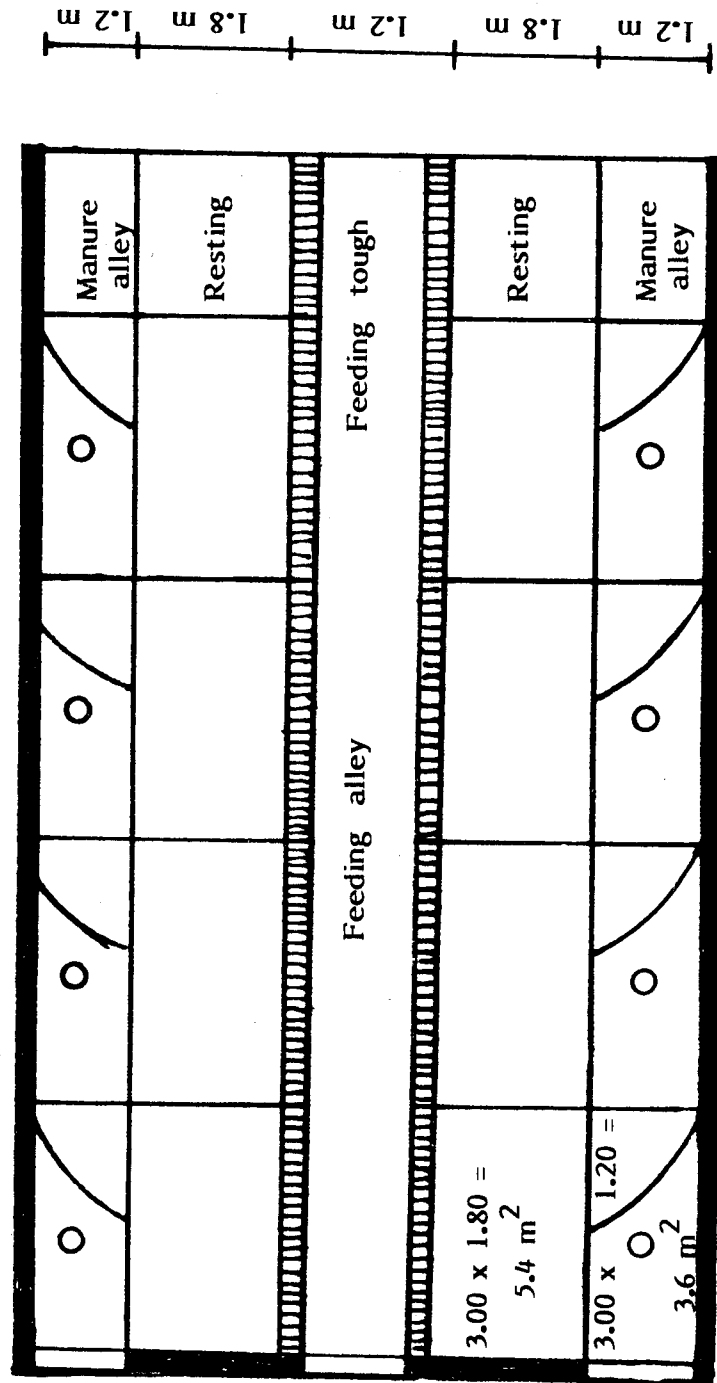


Fig. 5.1.7.2 Housing Plan for Growing/Finishing Pigs.

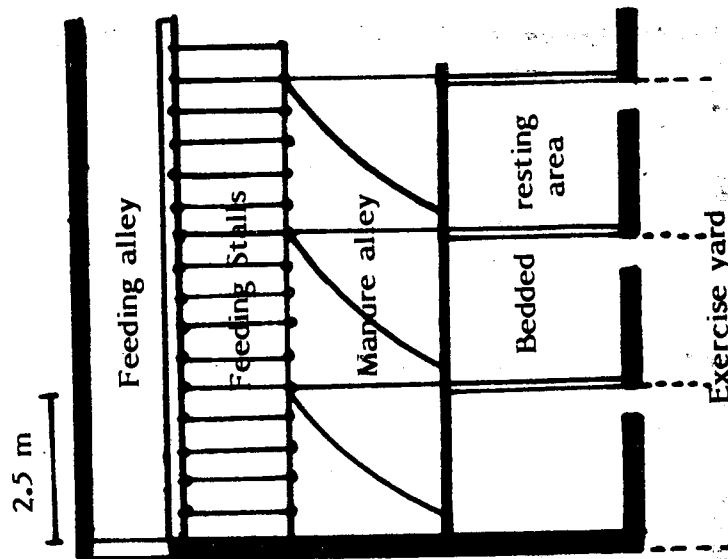


Fig. 5.1.7.3 Housing for Gestating Sows.

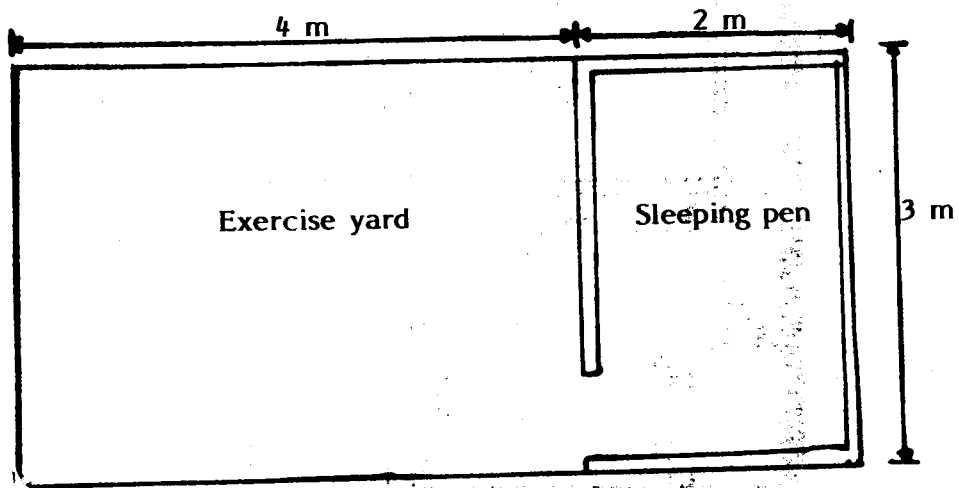


Fig. 5.1.7.4 Housing for Boar.

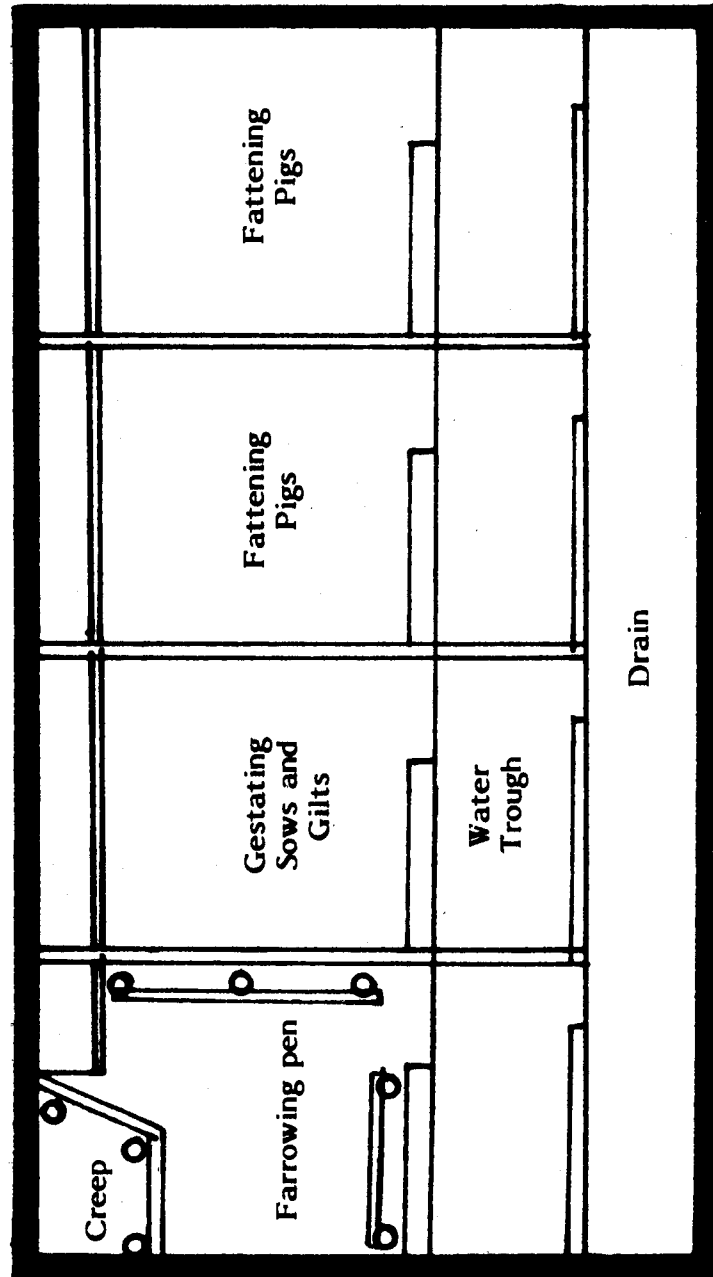


Fig. 5.1.7.5 Outline of Combined Housing Plan.

5.1.8 Climatic requirement and Modifying the environment

There is a need of special arrangement for different type of climatic conditions for efficient pig production. When the natural environment is outside the range of the pigs various device can be used to modify the environmental condition to make it more suitable.

In winter season, the open windows may be covered with screens which may be made up of fabric, canvas or woven with leaves or corrugated iron or asbestos. This will help to reduce the air movement through building and retain more of the heat produced by the animal. The screens should be completely removable, because they can be partially deployed in changeable weather. In places where night temperature falls the pigs require supplementary heating either by lamps or by heaters.

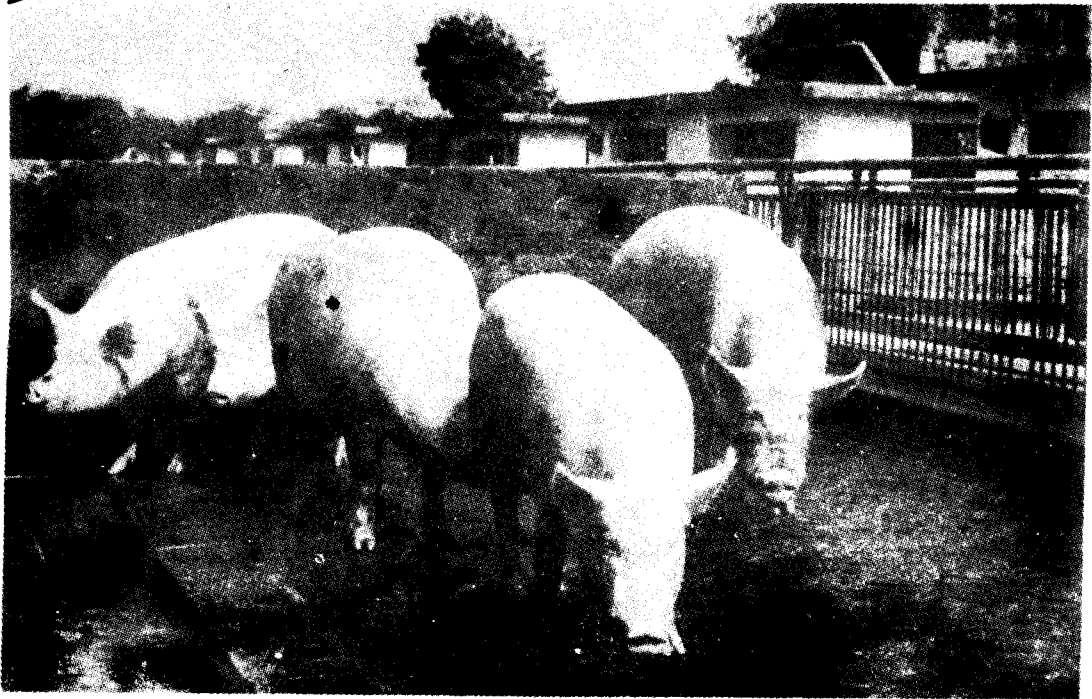
When the temperature rises above the comfort zone additional cooling is needed. It can be provided by the following ways:-

1. All screens should be removed. Increase air movement through the open side of the buildings will help in reducing the temperature.
2. The roof should be painted white on outside and black on inside. Hay, straw or other plant materials gives excellent shade.
3. A spray or a wallow can considerably reduce heat stress in pigs. Wallows, which are simply small troughs of water can be made of brick, concrete etc. The drainage system and cleaning is very important from the health point of view. Sprinkler methods of watering have produced better results to keep the temperature low as they are evenly distributed amongst all the pigs. It is also hygienic, require less water, not occupying pen space and can be operated as and when necessity arises.
4. Cooled drinking water may effect on growth and feed conversion efficiency.
5. Evaporative cooling is helpful in areas with low relative humidity. It consist of exhaust fans arranged to take fresh air into building through a wet pad.

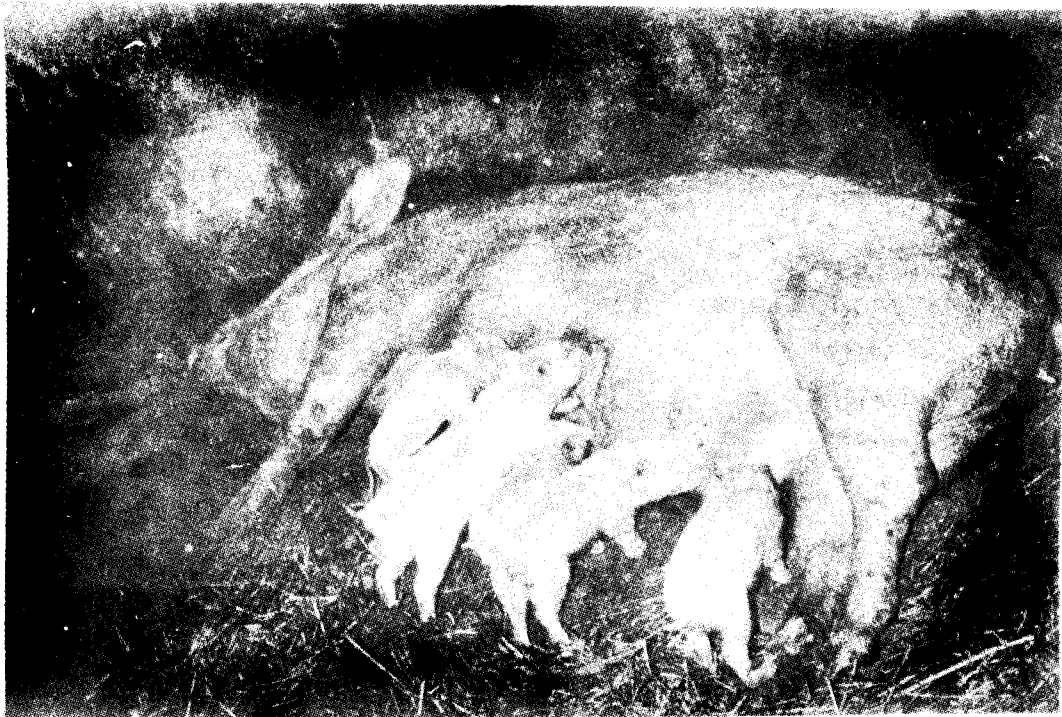
5.2 Management

5.2.1 Systems of management

The systems of management plays an important role in pig farming and it provides the conditions which permit the animals to function to the maximum of their capacity. The systems of production that is followed on a piggery farm includes daily routine of handling the animals within



Modern Pig Sty



82

Local Sow with New born Piglets

the limitations of the conditions. Planning and modification will increase the effectiveness of management.

The breeding herd offers greatest reward for good management. The good management of breeding herd solves problems of breeding, sterility, gestation, farrowing lactation etc. The skillful management of the breeding herd increases the savings. These savings are carried all the way through the production cycle and show up best economic return at market times as extra profits. The breeding herd are maintained for two purpose, i.e. to produce pigs for the finishing pen and to provide replacement stock of breeding animals. The cost of maintaining a breeding herd on the average farm accounts for approximately one third of the total cost of producing pork.

The duration of gestation and lactation of the sows can be combined in such a way that they produce two litters of pigs a year. A combination of the one and the two litter systems to provide three farrowings a year can be practiced on farm. The two litter sows are bred to farrow in March and September and the gilt herd in June. The performance of gilt and sows differs. Sows, on the average, farrow one or two more pigs per litter than gilts do, but gilts raise a larger percentage of the pig they farrow.

The size of the pig enterprise can be enlarged either by increasing the number of farrowing sows at a given time or by increasing the number of the farrowing periods in a year. Available building space will of course, control the number of sows that can be farrowed in one period.

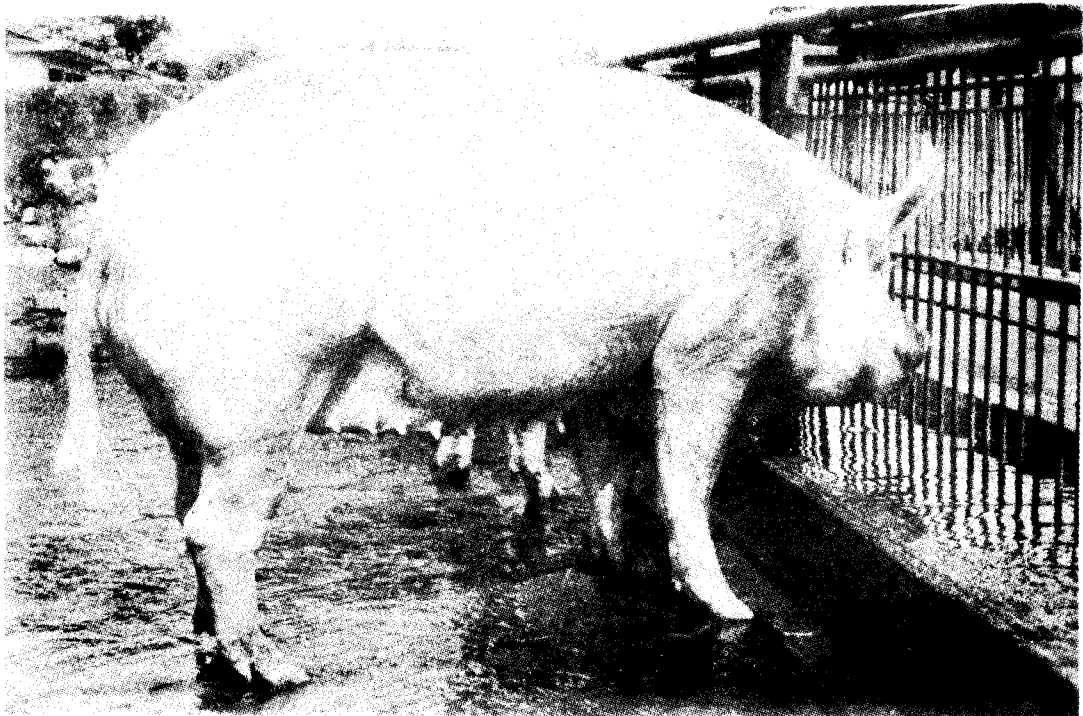
The confinement rearing and automation in pig industry will reduce the cost of labour. The system of rearing should be chosen according to the size of the farm. As specialisation and size of the pig production units increase, confinement systems will become increasingly important.

The farrowing dates influences the profits in pig industry. If piglets are born in severe weather, their chances of survival are greatly diminished unless supplemental heat is provided by the use of heat lamps, pig hovers and farrowing crates. These precautions add to the cost of the operations.

The litter size is also influenced by breed, strain, nutrition etc. The age of the sow has the greatest influence on the size of the litter farrowed. The number of pigs a sow farrows per litter increases with the advancement of age until the sow is about 2.5 to 3 years old, remains approximately constant until she attains 5 years of age and then gradually declines. The breed differences in the number of pigs farrowed per litter exist. The yorkshire breed of pigs generally excels all other breeds in the size of litter farrowed. The disease is another major factor which may reduce the number of pigs farrowed. Any infectious disease or low-grade infection of the genital organs of the sow may prevent conception.



Middle white York Shire Sow



A Pregnant Gilt

Even if conception takes place, infection may terminate into abortion.

5.2.2 Management of gilts and sows Mating to pregnancy

There are number of factors which results in the production of low litter size from gilts. These includes age and weight at mating, breed, flushing and timing of mating and reproductive behaviour of the boar, including its ability of fertilization. Gilts become sexually mature when they are 6 to 8 months of age if they have been liberally fed. The number of eggs shed is lowest at first heat. The conception rate is also lower following service at first heat hence, service at second heat is preferred.

The gilts are to be kept separately from the boars to avoid accidental breeding. They may be observed for oestrus. In general the signs of heat or oestrus is recognised by the willingness of the female to accept the male. The boar can be used for detection of heat. The optimum time of mating is 10 to 20 hrs before ovulation to maximise conception rate and litter size. Two or more matings are required to increase the size of litter. The contact with mature boar should be direct by allowing a boar into the pen for atleast 15 minutes each day under supervision. A better response will be obtained by leaving the boar for 24 hours per day with the gilts for the first four to five days until the first gilt show signs of coming into oestrus. At this stage, the boar should be removed and can be introduced to the gilts for a short period under supervision. Most of the gilts in the group are expected to show their first standing heat after stimulation within 5-10 days. This response can be synchronized. After showing the first heat, the gilts should be flushed for 10 days prior to the heat number at which the gilts are to be served. As soon as the gilts are served, high level feeding should be discontinued so as to minimise embryonic losses. Three weeks after mating every gilts or sow should be checked for signs of oestrus. If signs of oestrus are not seen, the gilt or sow should be housed separately. They should be normally given a constant intake of feed and ration, & should be increased during the last three weeks. The average gestation period in swine is 114 days with a standard deviation of 2.2 days. Approximately 105 days after conception, that is about one week before expected date of farrowing sows or gilts are moved into farrowing pens.

5.2.3 Management during farrowing and suckling

Management during farrowing and suckling reduces the percentage of losses from death of the pigs. It is estimated that 80 to 90 percent of the death losses occur within three or four days after farrowing.

Housing:

Types of houses are described in "Housing". Either portable or central type houses may be used to provide quarters at farrowing time.

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Ranikhet, Gumboro	} 15 mts.	E Coli, Fungus, Salmonella, Pseudomonas, Staphylococcus	} 5 mts.

SPECIAL FEATURES

- It can be used at low concentration. The effective concentration is only 4%.
- Microbes do not develop resistance to it.
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Portable houses, pens and farrowing stalls in the permanent, central type house should be cleaned and ready for use several days before the sows are due to farrow. The sow should be placed in farrowing stall a few days before with a view to familiar herself with the new surroundings. The size of the pen needed will vary with the age and size of the sow, pig brooders and guard rails etc. Pens 7 feet wide and from 8 to 10 feet long are preferred. The house should be clean, dry relatively warm and well ventilated.

Sanitation:

Losses due to swine diseases and parasites can be avoided in part by proper cleaning of the farrowing pen before it is used. All dust, dirt and litter should be removed and the floors and walls from 1'6" to 2' from the floor level should be scrubbed with boiling lye water or disinfected by use of steam cleaner. After the cleaning of the pen, it should be sprayed with a good disinfectant. A 2 to 3 percent of saponated solution of cresol is very effective. Equipment used in the pen should also be cleaned and sprayed. The sides, underline, feet and legs of the sow should be brushed and washed with a soap and warm water before she is placed in farrowing pen. Traffic into the farrowing house should be restricted.

Bedding:

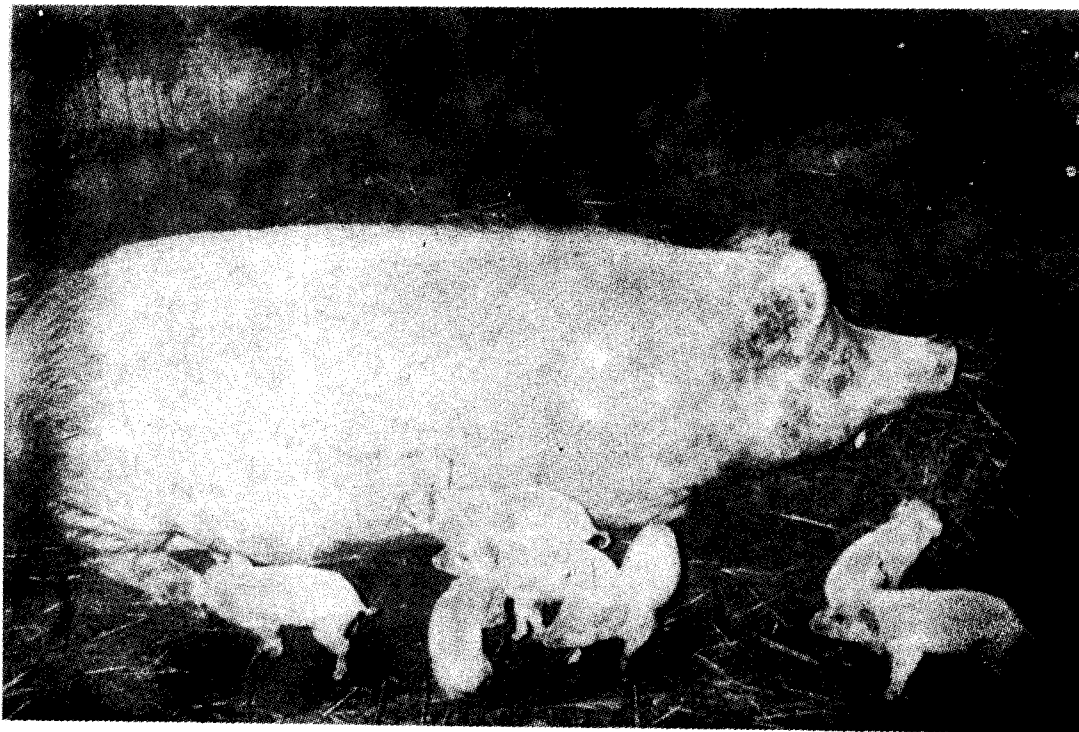
Coarse ground corn cobs, wood shavings, fine straw or sawdust may be used for bedding. The beddings should be kept clean, dry and well distributed. Removing the sow from the pen or stall each morning and evening for brief exercise, helps to keep the pen clean and dry.

Guard Rails:

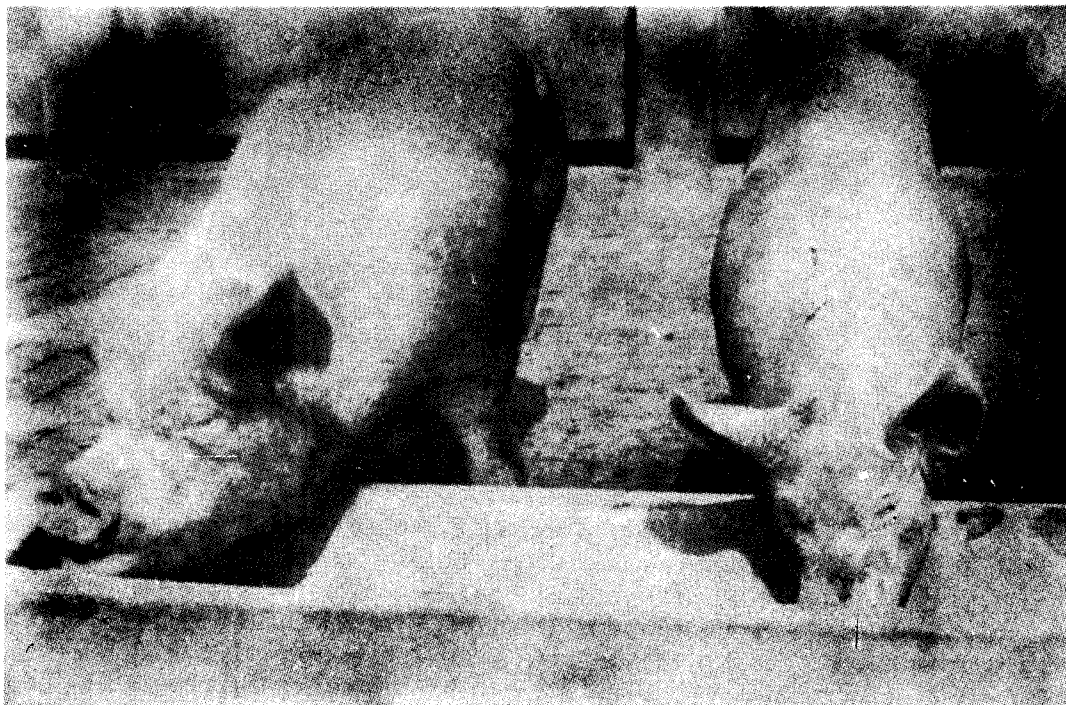
A number of devices have been developed to keep away sows from lying on the piglets. A simple device is the guard rail which is placed on the three back sides of the pen about 8 to 10 inches from the wall 8 to 10 inches from the floor. These may be made of metal pipe. They should be installed several days before the sow is due to farrow.

Heat lamps or brooders:

The temperature in the farrowing house should range from 50 to 60 degree. When temperature drops below 50 degree, the little pigs chill and may catch cold. The use of heat lamps or pig brooders is recommended. The infrared heat lamp type of brooder usually consists of a drop card with a mechanical support, a socket, a heat bulb and a protective reflector with a screen over the end of the reflector. The bulb should be a 250 watt lamp. The unit should be placed about 30 inches above the top surface of the bedding. The brooders should be installed several



Cross Bred Sow (Local XLWY) with Piglets



Pigs fed under Indoor System

days before the sows are expected to farrow.

Assistance at farrowing time:

Most sows farrow within 24 hours after milk develops in the nipples. In colder months the piglets should be placed under the brooder or heat lamp. The piglets should be returned to the sow to suckle mother's milk as soon as possible. Each piglets will normally suckle for two to three hours. Weak piglets incapable of sucking mothers milk should be nourished with due care to regain their health. Bottle feeding can be practised in case of agalactial condition of the mother. Sows may have difficulty at farrowing, it is best to have a veterinarian to render assistance. Some times the navel cord is long and it should be cut with the help of a scissor or blade after properly disinfecting with tincture of iodine or antiseptic solution like dettol, lysol, weak solution of potassium permagnate etc.

Identification marks:

Ear notching as means of identification of pigs is widely used. Where there are large number of pigs and it is difficult to identify them by means of their natural marking brand. Identification is necessary for entry into herd books/stock register of the farm, insurance purposes and for giving certificates following the performance of diagnostic test, for official purpose and for identification in the case of transportation to other places. Exotic breeds of pigs are usually indentified by numbers of letters in the ears. Eartags made of aluminium or plastic with the numbers and letters stamped on it are used. Tattooeing does not work in black coloured breed, hence ear notches are used. In both the ears a series of notches are made. The common standard eartnotching system is as follows:-

One notch in the lower, right ear is 1

one notch in the lower left ear is 3

one notch in the upper right ear is 10

one notch in the upper left ear is 30.

It is estimated that from 25 to 30 percent of pigs that are farrowed fail to reach the weaning age of eight weeks. Good management determines a high percentage of survivality in the litter and attain a healthy heavy weight at weaning time.

Feeding the sow:

A sow, when fed a good ration may produce from 3 to 4 kg of milk per day. The sow must receive feeds containing important nutrients in sufficient amounts to produce the milk required by the litter.

Feeding the piglets:

After farrowing it should be observed that every piglet is getting required quantities of milk, if not, all piglets should be artificially fed on cow's or goat's milk. But it is a laborious business. A much better way is to foster them onto another sow. This may be another sow which has farrowed approximately at the same time but the foster mother must have spare teats.

5.2.4 Pre-weaning Management:

Docking and teeth cutting:

Some producers find it necessary to cut piglets teeth or dock their tails. Piglets have needle sharp teeth which can cause injury to the teats while sucking mothers milk and during fighting to each other. Both teeth cutting and docking are done with a pair of wire cutting pliers often called side cutters. These are sterilized in antiseptic solution before and between uses. Tails are treated with antiseptic after cutting.

Castration:

Pigs are castrated at the age of two to four weeks, by open method of castration on the scrotum.

5.2.5 Management from weaning to market:

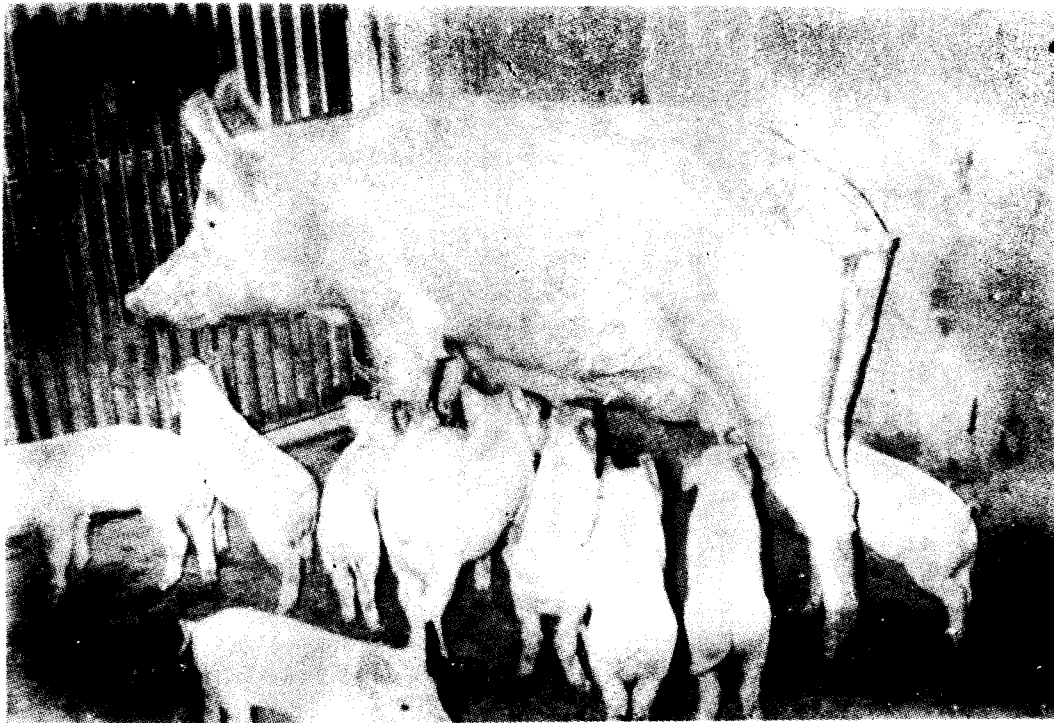
Weaning:

Piglets are generally weaned at the age of 8 weeks. There are certain advantages of early weaning. With the use of fortified pre-starter, starter and grower rations, it is possible to wean the pigs in advance. Early weaning will reduce pre-weaning percentage of mortality, prevent losses in weights of the sows and permit earlier rebreeding of the sows. Less floor space is required when pigs are weaned early.

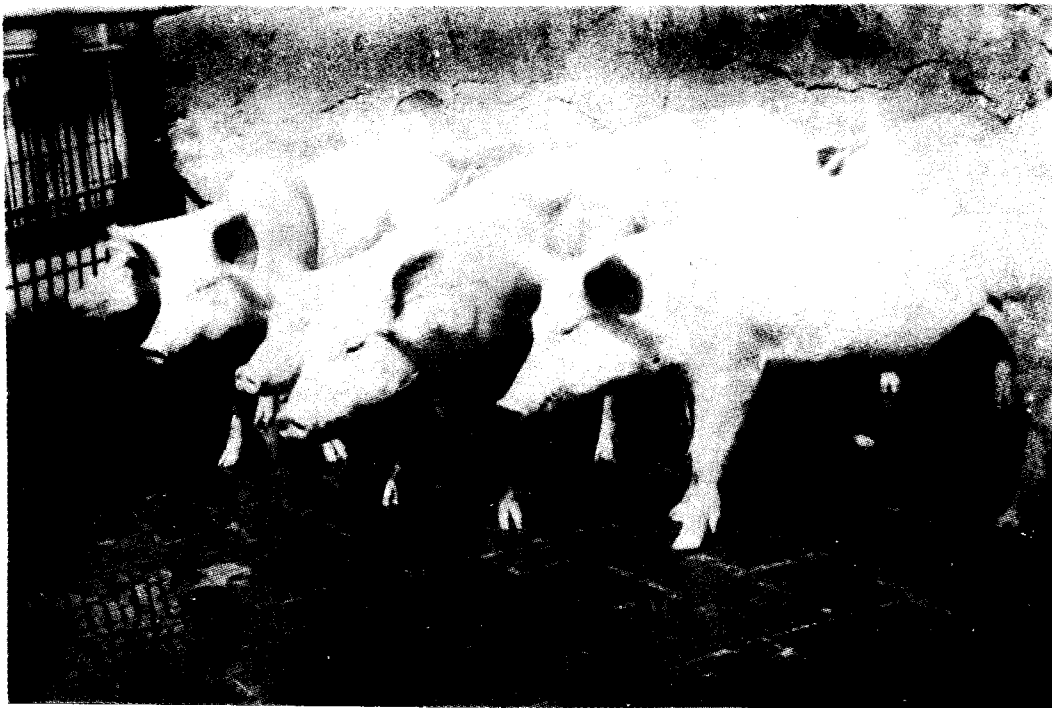
There are certain disadvantages of early weaning. Early weaning of pigs requires special rations, which are expensive. Good management is essential to successful early weaning of pigs, otherwise it will result in high mortality.

5.2.6 Health Cover:

Results from very best methods of feeding and breeding will be lessened if sanitation and measures for proper health cover are neglected. It is important to keep constant observation in the herd.



A Nursing mother of Large White Yorkshire



A Healthy Stock of Growing Pigs

General measures:

1. Newly purchased stock should be isolated for at least a period of 30 days before they are allowed to mix with the old stock. During the isolation period all animals should be examined against parasitic diseases and other bacterial diseases.
2. Movement of stray animals etc. in the farm area should be prohibited. Visitors are allowed only after proper dipping of their shoes in a solution of strong antiseptic or disinfectant. Visitors should not be allowed at least during an outbreak.
3. Pigs are required for vaccination against swine fever in between 6-8 weeks.
4. Deworming of piglets on 21st day and follow up action at two months interval is highly effective against round worms.
5. To prevent ectoparasites particularly on mange infestation, 25% Benzyl Benzoate solution, Cythion (05 percent) spray locally every alternate day for 5-7 occasions will show good result.
6. Piglets under confinement system of housing must be injected with iron (Imferon) injection on 7th and 14th Day to prevent piglet anaemia.
7. Regular cleaning of the shed, maintenance of sanitation and hygienic condition, proper disposal of sewage materials from the farm should be the routine practices.

5.2.7 Management of Growing/Finishing pigs:

The husbandry of pigs from weaning to slaughter is easier and simple. The main problems are to insure a high feed intake, specially during the early phase and avoid problems of overcrowding, uneven groups, bullying and other vices. Pigs from different litters can be mixed after weaning. Most pigs should be fed ad libitum atleast in the growing stage till attaining live weight of 50 kg or above, depending on their feed efficiency and carcass quality requirements of the chosen market. One feeder space should be provided for every three pigs.

5.2.8 Management during transportation and slaughter:

When pigs have to be transported long distances over poor roads, losses from death can be increased. The stress factor, coupled with over loading and hot weather can cause losses of 2 to 5 percent of the pigs during transportation. When trucks are used for transport in cold weather, tarpauline or building paper over and along the sides of the truck will

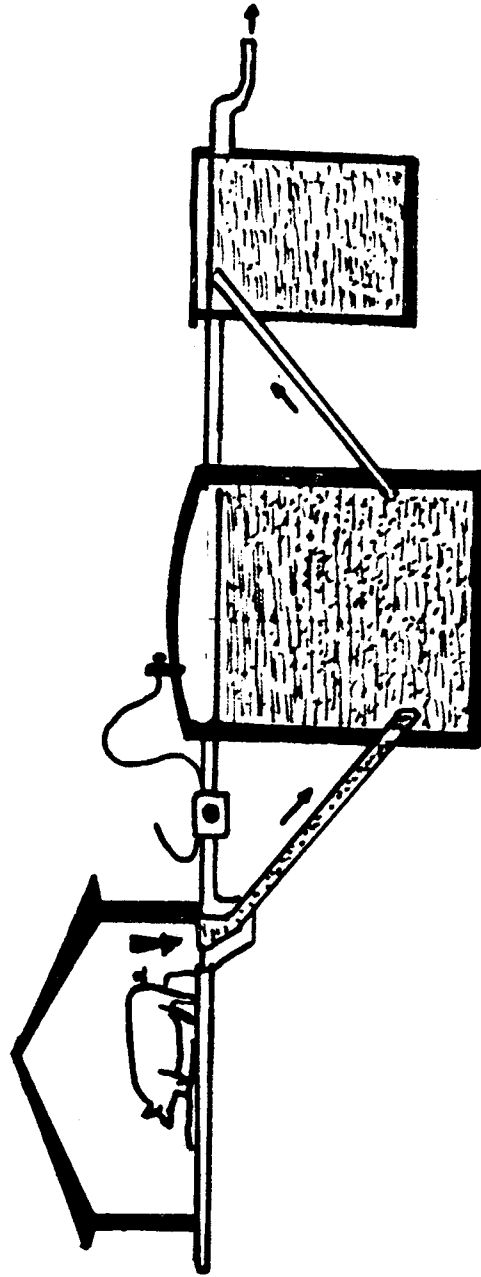
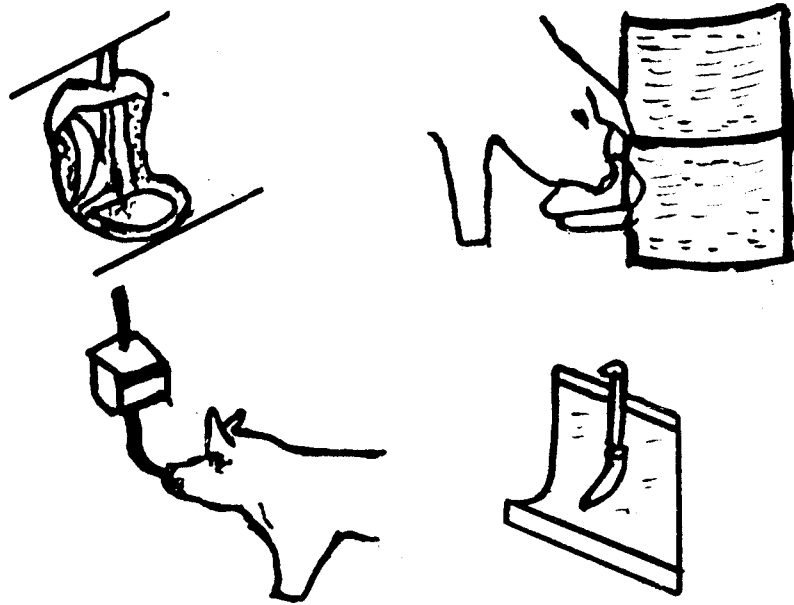
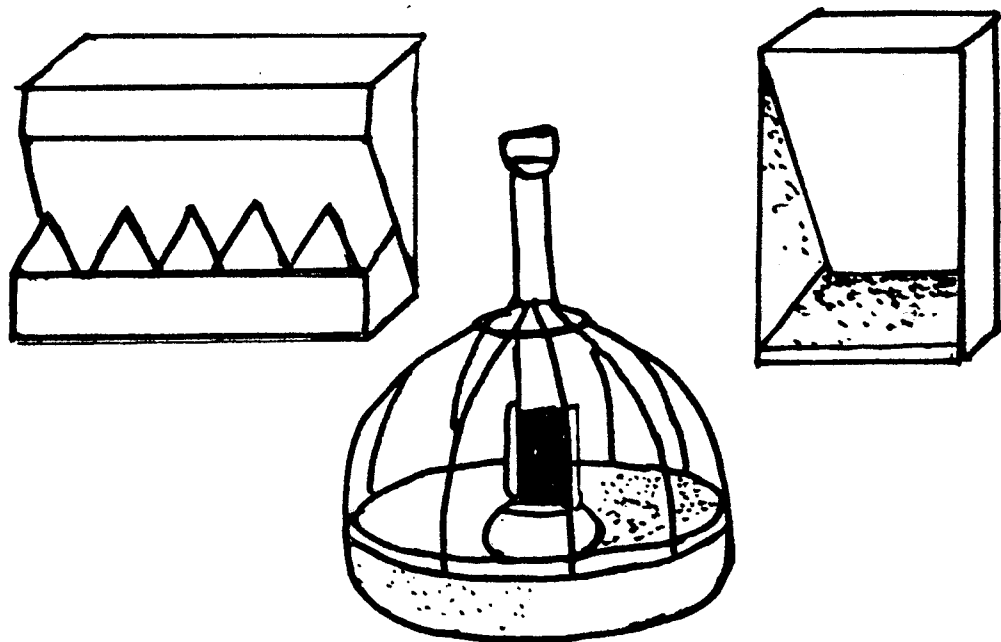


Fig. 5.2.9.1 A Simple Methane Generator.

(Handle wastes from approximately ten finishing pigs)



Alternative drinking System



Alternative designs of self-feeders
Fig. 5.3.1 Equipments for Pig Production.

considerably reduce the hazards. In hot weather, water should be thrown over the hogs at stops enroute, will prevent death loss. They should also be subdivided in small groups. The best time for transportation of pigs is early morning or evening, when it is coolest. Pigs going direct for slaughter within a few hours of leaving the farm may be kept on fasting at least for 12 hrs before slaughter. During that period plenty of water should be provided.

5.2.9 Waste disposal

Waste disposal is one of the important decisions which have to be taken very early in planning a pig enterprise. For a small pig unit on a mixed farm the fertilized value of the wastes is an asset, rather than a problem. However, for bigger units, particularly in specialized farming with less land holdings the disposal of wastes needs to be thought of in advance. In some areas vegetable or fruit growers provide a ready market for manure, but it has to be supplied in dried form. Ten pigs produce approximately 30 kg. of dung and about 75 kg of liquid. The effective way of waste disposal is through bacterial break down in a settling tank in the absence of air. In a closed airtight chamber, methane gas is produced which could be used for cooking, heating etc. This process works rapidly and efficiently in summer season. But it may stop during winter. It is possible to use some of the gas produced to warm the fermenter but it requires complex engineering. A methane generator suitable for the wastes of ten pigs is shown in Fig. 5.2.9.1. The fermenter chamber can be built of brick concrete block. A digester of this size would produce about 3500 litres of gas per day.

5.3 Equipment-key factor in the cost of production:

The equipments make to a rigid program of sanitation for efficient pig production. Equipment should be designed for efficient use and for economy of labour at every point where this can be done. The proper kinds of equipment provided in suitable amounts and used effectively make a definite contribution to keeping costs low. The equipments include pens, movable houses, farrowing pen, guard rails, farrowing crates, brooders, feeders, sprinkler system for cooling, drinking system, feed handling and storage and equipments for waste disposal. Some of the important equipments are shown in Fig. 5.3.1.

Whatever equipments which are used for pig farming should be substantial in both material and construction. So that it can withstand the prodding of the pigs powerful snout and the pressure of their heavy body. The construction must permit easy and complete cleaning, as a matter of good sanitation.

CHAPTER VI

NUTRITION AND FEEDING

6.1 Role of Nutrition & Feeding of Pigs

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6.1.1 The importance of feed and nutrition to pig production

The feed accounts about 80 percent of all costs. Efficient use of feed will ensure the profitable pig production. Efficiency of conversion does not guarantee of profitability achieved by expensive ration. The important point which is to be considered is cost of feed per kg of pork produced. The feeding of cheaper rations based on locally available materials, may not produce fastest gain but will reduce the feed cost per kg of carcass weight gained. Therefore, it is highly important that economical as well as nutritionally balanced diets are provided during all phases of the life cycle. The economics of swine feeding are largely dependent on local conditions of feed stuff availability and competition for use by either humans or other animals. The pig has a simple digestive system with limited ability to utilize large quantities of forage like the ruminants. Practical swine feeding consists of meeting the biological needs with proper combination of feed ingredients and pure sources of limiting nutrients to yield an economical and nutritionally balanced diet.

6.1.2 Nutrient Requirements of Pigs

The nutrient requirements should prescribe that amount of each essential nutrient that will result in maximal production with a minimum of overfeed. The nutritional needs of different period of life cycle like gestation, lactation, suckling, growing, finishing etc. should be met to promote optimum performance. Therefore, a knowledge of minimum requirements is of direct practical significance in the formulation of balanced ration for the sows. The nutrient requirements of pigs during the different phase of the life cycle is shown in Table 6.1.2.1.

6.1.3 Significance of Nutrients in the diet of the Pigs

Energy

Energy is the largest and important component of swine diets. Most of the energy fed to the animals is wasted. It is possible to control the inefficiencies of energy use by selection of nutritionally balanced diets. Energy is yielded by the carbohydrates, fats and proteins. Most of the energy needed by the pig is supplied by dietary carbohydrates,

Table 6.1.2.1 : Nutrient requirements of swine (amount per day).

Nutrient	Stage of life						
	Growing (body wt, kg)			Gestation/ Breeding boar (body wt, kg)		Lactation (body wt, kg)	
	5-10	10-20	20-35	35-60	60-100	110-250	140-200 200-250
Digestible energy, 2,100 kcal		4,370	5,610	8,250	11,550	6,600	16,500 18,150
Crude protein, g	132	225	272	350	455	280	750 825
Inorganic elements							
Calcium, g	4.8	8.1	10.2	12.5	17.5	15.0	30.0 33.0
Phosphorus, g	3.6	6.3	8.5	10.0	14.0	10.0	20.0 22.0
Sodium chloride, g	-	2.9	2.9	-	-	10.0	25.0 27.5
Vitamins							
Vitamin A, IU	1,300	2,200	2,200	3,250	4,550	8,200	16,500 18,150
Vitamin D, IU	132	250	340	312	437	550	1,100 1,210
Thiamin, mg	0.8	1.4	1.9	2.8	3.9	2.8	5.5 6.0
Riboflavin, mg	1.8	3.8	4.4	5.5	7.7	8.2	16.5 18.2
Niacin, mg	13.2	22.5	23.8	25.0	35.0	44.0	88.0 96.8
Pantothenic acid, mg	7.8	13.8	18.7	27.5	38.5	33.0	66.0 72.6
Vitamin B ₁₂ , µg	0.9	18.8	18.7	27.5	38.5	27.6	55.0 60.5
Choline, mg	660	1,125	-	-	-	-	- -

Source: National Research Council, 1968.

but pig do not have specific enzymes for digesting plant cellulosic based carbohydrates. Fat is very high in energy. Protein is the least efficiently used of all sources of energy and needed in the synthesis of new body protein. The digestability of energy varies in different ingredients and the size of the particle also influences it. The digestibility of fats and oils is 20-90 percent; carbohydrate in the form of starch is 95 percent; plant cellulosic compounds is very low. The digestibility of cereal grains can be improved by reduction in the particle size by fine grinding and cooking.

The energy is required for maintenance, production and growth. The estimates of maintenance needs of energy of pigs varies between 0.4 to 0.5 MJ ME/kg metabolic body weight. The requirement of energy increases in pregnancy, milking and growth. During the growth, the energy required for maintenance increases with the size of the animals. In initial stages of growth the energy is converted into the protein but in later stage most of the energy is utilized for conversion of body fat. The body temperature of pigs must be maintained in the region of 39°C to avoid large quantity of wastage of energy for the control of body temperature. Energy given to pigs goes first to satisfy the needs for gestation and milk production and then for maintenance. The low supply of energy will lead to losing of weight in pregnancy and lactation. The energy should be supplied by calculating the requirement to avoid losses and to cut down the production costs per kg of pork produced.

Protein

The protein is needed for growth, maintenance and production. Inadequate dietary protein causes the slow growth and inefficient feed utilization. The protein requirements for gestation and lactation are more, but it appears that lactation is considerably more critical. The protein is also needed for fertility and long term reproduction. The reproductive performance in terms of number, weight and composition of piglets born per litter is maximized when the sow is given a daily allowance of 140-180 g crude protein subject to the meeting requirements for amino acids. The amino acid requirement of the pigs is shown in Table 6.1.3.1.

Minerals, Vitamins and water

Though minerals and vitamins are needed in small amount in the diet but it has been shown to produce a maximum response of characteristics of economic importance.

Minerals and Trace elements

The calcium and phosphorus are required in large quantity and to be supplied in the diet. The other mineral requirements of pigs are largely supplied by minerals occurring naturally in the feedstuff of the

Table 6.1.3.1 : Aminoacid Requirements of Pigs (Amount per kg of diet)

Aminoacids%	Growing (body wt. kg)				Gestation/ Boar (body wt. kg)		Lactation (body wt. kg)	
	5-10	10-20	20-35	35-60	60-100	110-160	140-200	
Arginine	-	-	0.20	-	-	-	-	-
Histidine	0.27	-	0.18	-	-	0.20	-	-
Isoleucine	0.76	-	0.50	-	0.35	0.43	-	-
Leucine	0.90	-	0.60	-	-	0.66	-	-
Lysine	1.20	-	0.70	-	0.50	0.49	-	-
Methionine	0.80	-	0.50	-	-	0.35	-	-
Phenylalanine	-	-	0.50	-	-	0.52	-	-
Threonine	0.70	-	0.45	-	-	0.42	-	-
Tryptophan	0.18	-	0.13	-	0.09	0.08	-	-
Valine	0.65	-	0.50	-	-	0.46	-	-

Source: National Research Council, 1968.

normal diet. These minerals can also be supplied in the form of mineral mixture. The aim of the mineral supplement should be to balance the total needs of the animals with the supply of elements already contained within the diet ingredients. Calcium, Phosphorus, Sodium and Chloride are normally added as ground limestone, dicalcium phosphate and trace mineralized salt. The salt serves as a carrier for trace minerals including iron, copper, manganese, selenium, iodine and zinc. The trace minerals are obtained from dietary sources.

Vitamins

Vitamins are substances present in natural feed stuff, essential for health which exercise an influence in nutrition out of all proportion to the amount consumed. Vitamin supplements now form an essential part of pig stock feeding. The vitamin requirements of pigs is shown in Table 6.1.2.1. The vitamins are added into pig diets in the form of composite premix.

Water

The water holds a paramount place in its importance in feed. There is a minimum requirement for water without which the welfare of the pig would be adversely affected. The temperature of the environment will influence the water utilisation. The frequency of drinking depends upon the dryness of the food and to the frequency of water loss from the body. Lactating sows need to drink more frequently than pregnant sows. It is also required to mix in feed to increase the palatability. The approximate water requirement is given in the Table 6.1.3.2.

Table 6.1.3.2 : An approximate guide to daily water allowances for pigs.

Stage of life Cycle	Minimum water (Lit/day)	minimum frequency of water provision (Times/day)
Sucking piglets	ad libitum	Freely available.
Weaned piglets	ad libitum	Freely available.
Growing pigs (20-90 kg)	1 - 6	Once or twice
Pregnant sows	4	Once or twice
Lactating sows	12 - 21	Twice but preferable freely available.

Non-Nutritive feed additives

Non-nutritive feed additives are the substances added to feed for the purpose of improving palatability; improving the texture of meals, prevention of rancidity, preservation of vitamin potency, curing bacterial and parasite infection, preventing infection and the promotion of growth. Feed antibiotics and antibacterial agents are used to control microorganism eg. Virginiamycin, moenomycin and Zinc bacitracin. The other compound which have bacteriostatic property like nitrosin, quindoxin, diametridazole and halquinol. Antibiotics are used for therapeutic use eg. sulphonamides, penicillin, nitrofurazone/nazazolidine, oxytetracycline etc.

Copper and arsenic compounds have growth promotive effects and is added in the diets of growing pigs. Pigs should not fed diet containing arsenic compounds 10 days prior to slaughter. Recently it has been proved that a combination of synthetic androgen (methyltestosterone) and a synthetic oestrogen (diethylstilboestrol) has achieved some success in the promotion of growth. The diet containing hormones should be discontinued 72 hours prior to slaughter.

6.1.4 Feed stuff and Modern Feed Formulations

The value of feed stuff in the formulation of rations is influenced by a number of factors which should be taken into consideration skillfully in formulating rations.

6.1.4.1 Characteristics of a Good rations

- i) A good ration should provide nutritionally based diet according to the changing nutritional requirement of animal throughout the life cycle.
- ii) A good ration should be nutritionally balanced.
- iii) It should be palatable and safe.
- iv) It should be adapted to the system of farming.
- v) It should be economical.
- vi) It should be readily available.
- vii) A good ration should be adapted to the environmental conditions.

6.1.4.2 Feed stuff for pig rations

A. Cereal Grains and By Products

The cereal grains and many by-products constitute a larger percentage of an important constituent of the ration. The addition of cereal grains and their by-products helps in raising level of protein, minerals and vitamins to the level required by the pigs. Most of the cereal grains and their by products are palatable to swine. The cereal grains are costly but the by-products are available on cheaper rate. The palatability of cereal based products can be increased by processing i.e. heat treatment, mixing with other feed stuff, cooling etc. The costly products are added to the ration to the limit of appetite. The selection of cereal grains and by products can be done according to the availability and cost and quantity of nutritive value.

B. Milk, Animal and Marine By-products

Cereal grains and other type of feed stuff must be supplemented with feeds that contribute additional protein to the ration. Milk, animal and Marine byproducts helps in increasing the quality of the feed stuff for gaining more feed conversion efficiency.

The milk products contains the excellent high quality of protein, vitamins and minerals and milk sugar i.e. lactose. Dried skim milk, dried butter milk, dried whey, cheese rind and dried whey soluble are some of the examples of milk products. Milk products are best for young pigs.

The modern meat packing plant byproducts, slaughter house waste, marine products are the important sources of swine feeds. In slaughter houses most of the byproducts are being wasted at present due to lack of availability of facilities for their processing e.g. Blood, bonetrimmings, inedible parts and organs, cleaned entrails residues, condemned carcasses. These products can be processed to form a very cheap and highly nutritive diet for the pigs. The byproducts of poultry dressing plants and hatchery waste can be processed and fed to pigs.

The marine based feed stuff provides pigs a clean, highly nutritive feed supplement. These include fish meal, fish residue meal. These products are excellent sources of several water soluble vitamins, high quality protein. The semisolid fish product contains important amounts of calcium and phosphorus. These products makes excellent ingredients in manufactured mixed rations or in supplements for swine.

C. Feeds of the Plant origin - Forages

The digestive system of the pig is not well adapted for dealing with fibrous and bulky foods. A large proportion of the ration must consist

of materials with a low fibre content. However, addition of forage may be advantageous as they are the excellent sources of essential vitamins and minerals. They permit the animals to have access to iron rich soil which aids in anaemia prevention.

6.1.4.3 Locally available Resources

All small farmers do not have access to compound rations at reasonable prices. Therefore, it is possible to make better use of locally available feed crops, offals and byproducts, hostel and kitchen wastes from hotels and Dhabas etc. The other local available resources includes Algal, Bakery waste, wasted bananas (damaged crops) blood meal, bone meal, bran (wheat, rice) vegetable and other fruit wastes, cassava, carrots, coconuts, distillery by products, hatchery waste, sugarcane etc.

6.1.4.4 Scales of Rations for various stages of production cycle

The ration should be formulated in such a way that it provides all essential nutrients and is economical and palatable. Different feed stuff can be used in various categories of weight and breeding. The ration should be given according to body weight and stage of the life cycle.

Scale to adjust rations according to body weight

1. Starter (Body weight 10 kg to 20 kg)

Body weight (Kg) 10 15* 20

% of 15 kg ration 80 100 120

2. Grower (Body weight 20 kg to 50 kg)

Body Wt(kg) 25 30 35* 40 45

% of 35 kg ration 83 91 100 111 120

3. Finisher (Body weight 50 to 90 kg)

Body Wt(kg) 55 60 65 70* 75 80 85

% of 70 kg ration 87 91 96 100 105 110 114

4. Pregnant sow (Body weight 120 kg to 200 kg)

Body Wt(kg) 120 160* 200

% of 160 kg ration 83 100 115

5. Lactating sow (Body weight 120 kg to 200 kg, suckling 6-12 piglets)

Body Wt(kg) 120 160* 200

% of 160 kg ration

Piglets in litter

6	71	85	95
7	75	91	105
8	80	96	110
9	83	100*	115
10	85	102	117
11	86	103	118
12	87	104	120

* The scale are expressed as a percentage of the ration for the mid-point weight.

6.1.4.5 Appetite-an important factor in the selection of diet

The amount of food a pig eats mainly depends upon its size and nutritional requirements. The appetite is also influenced by the digestibility of the diet, energy density of the diet, its physical form and method of presentation, its palatability and the environment of the pig. An excessive appetite in pigs reduces the carcass quality by deposition of over fat. Excessive appetite also reduces the feed conversion efficiency. Piglets under stress eats less feed. Appetite in sows is influenced by their body resources of fat and the stage of pregnancy and lactation. Pregnant sows eat more than nonpregnant sows of the same weight. Feed intake is linked to milk production, high milk producer will eat more than low yielders.

6.1.4.6 Feeding during various phases of life cycle

Feeding sows and gilts during breeding season

During the breeding season gilts and sows in dry lot will gain about a pound a day if they receive 1.3 to 1.7 pound of concentrates daily per 100 pound of live weight. With gilts being served during their second or third heat periods, flushing is possible for the last 10 days before service and during this period the feed should be increased to 3.5 kg per day. Flushing for this period of time increases the ovulation rate and this can increase the litter size by one or two piglets. This level of feeding is maintained for 2 days after service to ensure that ovulation is completed. The level of feed can be reduced to 1.8 per day and continued until the stage of pregnancy.

Pregnant sows and gilts

The feeding scale for pregnant sow will depend upon the size of sow or gilt, desired rate of growth and stage of pregnancy. There is a need for a sow to gain weight in pregnancy to protect the depletion of maternal body, and for good lactation. **The obesity in sows is not desirable as it reduces the embryo and foetal survival, creates problems at farrowing and lactation.** In addition to this deposition of excess fat increases the maintenance cost.

Lactating sows

Feeding of lactating sows depends upon the productive capacity of the milk, size of the litter, weight and age of the sow. The lactation ration should make allowance for the next conception.

The feeding of piglet

The lactating sow is a supremely competent mammel which efficiently converts dietary nutrients in the milk. It is important for her to support a gain in the live weight of her litter of 2.5 kg/day during the first three weeks of lactation. Colostrum (first milk) should be fed to piglets for protecting them against disease.

It is common commercial practice to offer feed to piglets while they are still with the sow in a creep area. The composition and amount of creep feeding differ according to the length of the suckling period. The composition of creep feed is important in achieving success at weaning. Early weaning is a relative term and is usually taken to refer to weaning at between two and four weeks of age. There are three types of approach for feeding of early weaned piglets. The first approach is to design diets to be as similar to sow's milk as possible but in the dried form and should be fed ad libitum. The second approach is to feed an inferior diet but to restrict the amount of feed, particularly in the first few days after weaning. The third approach to early weaning diets is virtually to find to balance between cheap constituents and the addition of antibacterial agents.

Feeding of Growing Pig

Pigs require more feed daily for maintenance and for growth. The appetite increases with size as well as the rate of fat deposition. For reducing the maintenance of the pig, it is important to restrict the appetite. It will also help in reducing the fat deposition.

The ration scale for growing pigs will depend on individual circumstances, economics, type of carcass desired. Young pigs can benefit from

ad-lib feeding. Ad-lib feeding has also advantage in terms of labour use and simplicity of management. However, the growth obtained may be rich in fat. Therefore, rationing by weight and by time plays an important role in reducing the cost of rations and to gain carcass which is more in lean meat than fat. Pigs can be weighed regularly and allocated their appropriate ration.

The rationing for different sexes influences their rates of deposition of lean meat. Thus the maximum rates for daily protein deposition has been suggested as 90 g, 120 g and for castrates, gilts & boars respectively.

Feeding Weaned Sows for Rebreeding

The condition of the sow at the end of reproductive cycle when her piglets are weaned is the result of the combination of pregnancy feeding, lactation feeding, milk yield and body condition. If these stages are managed properly there will not be any problems in rebreeding of weaned sows. Normally, sows will show oestrus four or five days after weaning.

Feeding Boars

Young boars are normally ready for service at around 7 months of age and to start with they should be used for a single service once or twice a week. For mature boars four or five services evenly spread per week is possible. For a averaged size boar the daily feed requirement is between 2-4 to 3.4 kg of meal used for lactating sows. Under feeding can reduce the boars fertility and overfeeding will increase live weight and reduce its libido.

6.1.4.7 : Rations for various stages of life cycle.

- i) Creep and Starter Ration (Body weight 2 kg - 15 kg)

Following rations are recommended for feeding of piglets.

Ingradients	American	British	Indian creep mixture
Rolled Oats	50	-	-
Soyabean	20	-	-
Maize Meal	15	-	-
Barley Meal	-	22	-
Wheat offal	-	20	-
Flaked Maize	-	20	-

Ingradients	American	British	Indian creep mixture
Wheat bran	-	-	10
Ground Yellow Maize	-	-	40
Ground Nut Cake	-	-	10
Til Cake	-	-	10
Skimmed Milk	-	15	10
Fish Meal	2.5	15	6
Dried Whey	2.5	-	-
Sugar	7.5	-	-
Molasses	-	-	10
Dried Grass	-	5	-
Brewer's Yeast	-	3	2
Mineral Mixture	2%	2%	2%
Vitamin (A+B ₂ +D ₃)	10 gm	10 gm	10 gm

ii) Grower Ration (Body weight 15 - 45 kg)

Following formulations are recommended for feeding of Growers.

a) Cereal Ration (Qty. in %)

Ingradients	1	2	3	4
Maize	30	20	60	20
Ground Nut Cake	20	10	10	10
Wheat bran	40	40	10	10
Milo	-	10	-	15
Til Cake	-	10	10	10
Rice Polishings	-	-	-	10
Any other grain	-	-	-	15
Fish Meal	7.5	7.5	7.5	7.5
Minerals & Vitamins Supplement	2.5	2.5	2.5	2.5

b) Non-Cereal Rations (Qty. in %)

Ingradients	1	2	3	4	5	6
Wheat bran	70	-	60	-	35	30
Ground Nut Cake	20	20	20	20	10	10
Rice Polishings	-	70	-	60	35	30
Yellow Maize	-	-	10	10	-	10
Til Cake	-	-	-	-	10	10
Fish Meal	7.5	7.5	7.5	7.5	7.5	7.5
Mineral Mixture	2.0	2.0	2.0	2.0	2.0	2.0
Common Salt	0.5	0.5	0.5	0.5	0.5	0.5
Rovimix (A+B ₂ +D ₃)	10 g	10 g	10 g	10 g	10 g	10 g

3. Finisher Ration (Body weight 45 - 90 kg)

Following formulations can be used according to availability of the ingredients.

a) Cereal Ration

Ingradients	1	2	3	4
Maize	40	25	20	25
Wheat bran	30	-	20	15
Ground Nut Cake	12	12	12	12
Til Cake	10	10	10	10
Milo	-	-	20	-
Other grain	-	15	-	15
Rice Polishings	-	30	10	15
Fish Meal	5.5	5.5	5.5	5.5
Mineral Mixture	2.5	2.5	2.5	2.5
Rovimix (A+B ₂ +D ₃)	10 g	10 g	10 g	10 g

b) Non Cereal Rations

Ingradients	1	2	3	4
Wheat bran	75	70	50	40
Ground Nut Cake	17	12	17	12
Til Cake	-	10	-	10
Rice Polishings	-	-	25	30
Fish Meal	5.5	5.5	5.5	5.5
Mineral Mixture	2.0	2.5	2.5	2.5
Common Salt	0.5	-	-	-
Rovimix	10 g	10 g	10 g	10 g

The above formula can be modified according to the local conditions.

6.1.5 Method of Feeding and Feeding Equipments

In modern intensive pig production the method of feeding and feeding equipments effects on productivity. Feeding methods should be choosen according to the aim of the production of type of meat, rationing system, form of food, type of food available.

6.1.5.1 Complete diets

Complete diets are those in which all the ingradientes are mixed together before feeding usually in dry form. These diets can be fed dry, as a meal or pellets, or wet, either by the addition of water to the feed in the touch at feeding time or preparing in liquid form.

6.1.5.2 Ad libitum Feeding

Diets which are based largely on bulky feeds can often be fed ad libitum because the pigs capacity will limit their energy intake. It is a labour saving in operation and allows the pigs to fulfil their full growth potential. The ad libitum feeding may cause a lot of food wastage, and the efficiency of food conversion is somewhat low. The finished carcasses tend to be rather fat. The young animals are fed ad libitum up to 45 kg body weight.

6.1.5.3 Restricted Feeding

The animals are given a measured amount of feed once, twice of three times a day. In this feeding the growth is restricted, but the feed conversion efficiency is improved. The quality of animals becomes

better by lean meat deposition. Ration feeding has a higher labour demand than ad libitum but there is a saving on wastage.

6.1.5.4 Appetite Feeding

In this system, the combination of ad libitum and ration feeding is applied. The pigs are given as much as food as it is thought they can clear up in 15-20 minutes and if some is left over the next feed is made smaller. It all is cleared well before the end of 20 minutes extra food is provided next time. This system is supposed to give excellent growth rates without the laying down of too much fat in the carcass.

6.1.5.5 Fine or Coarse grinding

Fine grinding increases the digestibility of many ingredients specially plant materials. But, fine grinding increases the cost of feed. In addition of this very fine grinding of some ingredients, particularly cereals increases the incidence of stomach ulcers.

6.1.5.6 Meal or Pellets

The cost of the pelleted feed compared to meal type rations will largely determine the economy of this method of preparation for swine feeding. Compared with meal, pellets generally improved performance, partly by reducing feed wastage and partly by increasing digestibility.

6.1.5.7 Wet or dry feeding

Wet feeding also reduces food wastage and may also increase digestibility. Wet feeding means mixing of dry feed with 2-3 times its weight of water in the trough. It gives slightly better food conversion and growth rate than dry foods alone. In dry feeding there is slightly less wastage and can be successfully used for ad libitum and rationed feeding.

6.1.5.8 Equipment for mixing, storage and feeding

Mixing: the simplest way of mixing a diet is with a shovel on the ground. Turning the mixture over six times will give mixing complete. For larger quantities and more regular mixing, a simple mixer like a cement mixture is suitable. Specialized feed mixers are also available but costly.

Storage: The feed ingredients should be stored under cover and in vermin proof containers if possible. If it is stored in racks, they should be raised clear of the ground and away from walls. These should be stored in dry form, as the wet feeds deteriorate rapidly and also very attractive to vermin.

Feeding: Equipment for feeding needs to be well designed to allow pigs good access to the feed but eliminate feed wastage. For feeding a ration, troughs of brick, concrete or sheet metal are also suitable.

For sows and boars a single large trough each is best. For self feeding hoppers or sheet metal are best. Self feeders also promotes sanitation and provides large feed storage space. However, these are expensive. A good self feeder should be available to the pigs for the supply of clean, dry feed at all times. For liquid feeding liquid food troughs and pipes carrying liquid foods should be installed.

6.2 Evolving Economic Rations for Swine

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Feed is the largest single item of cost in pig industry, which accounts to 80% of total cost of production. Therefore, swine producers must constantly strive to reduce the cost of production by making more efficient utilization of locally available feeds and by-products that are not suitable for human consumption.

Maize, barley, sorghum and oats should be finely ground for feeding of swine. Medium to coarse grinding of wheat is the best as its fine grinding makes it pasty and less palatable. Triticale, a man made cereal can replace the maize. Fine grinding of feeds is also associated with the increased incidence of stomach ulcers. Pelleting of feed improves feedlot performance while cooking, soaking and fermentation are of little value to swine. The proportion of grains is usually limited to 20-30 per cent while the brans can be included upto 60-70% of the ration to make them cheaper. For growing pigs, the proportion of grains is kept on the higher side.

Cotton seed cake containing gossypol is not generally recommended because of the susceptibility of pigs to gossypol poisoning. In our country, groundnut cake (GNC) is the major vegetable protein being used in pig rations because of high palatability. Guar meal (GM), the residue left after the removal of germ from the seeds, was tried and found economic in growing, finishing pig diets, since it is quite rich in protein (36-46%) and has better amino acid profile than GNC. The results indicated that Gur meal can be included to the extent of 12% replacing 66% of GNC in pig finisher ration without any adverse affect (Table 6.2.1).

Table 6.2.1 : Replacement value of some of the alternative feed ingredients for swine.

Feed stuff		Level of inclusion in the ration(%)	Replacement value (%)	Recommended level of inclusion (%)
Conventional	Alternative			
Maize	-	50	-	50
-	Triticale	20	100	50
Rice bran	-	20	-	-
-	Brewers spent grains	-	75	15
-	Spent coffee grounds	-	50	10
Groundnut cake(Grower)	-	20	-	-
GNC(Finisher)	-	18	-	-
-	Guar meal (Grower)	-	75	15
-	Guar meal (Finisher)	-	66	12
-	Dried inactivated Yeast(grower)	-	75	15
-	Proto-O-Liv (grower)	-	50	10

Fish meal, meat meal, blood meal are generally added to balance the ration. Spent coffee grounds (SCG), a waste product of instant coffee industry, was incorporated in growing, finishing pig rations, which resulted in more lean carcass with less back fat thickness. Brewery waste, a by-product of brewery industry was tried in pig rations and found that it can be successfully replaced upto 15% without affecting the feed lot performance.

Kitchen waste contains mostly the left over mixture of chapaties, rice, vegetables, meat bones etc. The pig can be reared by feeding kitchen waste alone. Feeding trials using various by products have been conducted by various workers. They found that slightly poor feed lot performance when ration was substituted with by products, but it reduced the cost of production.

6.3 Feeding Gilts and Sows

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Reproductive efficiency is generally measured in terms of the number of pigs weaned per sow per year and is influenced by (1) the number of pigs born and weaned per litter and (2) the number of litters produced per sow per year. A further important criterion of reproductive efficiency is the number of litters produced per sow per lifetime or culling rate. Reproductive efficiency will be maximized by mating gilts early and keeping them producing large healthy litters for as long as possible. The long term reproduction of the sow is best served by minimizing weight and fat loss in lactation.

Survey data has shown that an average of 30 to 45% of sow are culled each year and must be replaced with gilts. Gilts produce smaller litters than sows and therefore a high culling rate will have a significant impact on the number of pigs weaned per breeding female per year. It is therefore, important that the gilts reproductive potential should be fully expressed. Among the factors that may affect the gilts reproductive performance are age, weight and body condition at mating, ovulation rate and the ability to be rebred after weaning her litter.

Effect of Food on Age at Puberty

If gilts are housed and managed with commercial pigs up to the market weight of 90 kg, most of them will have reached puberty by that time. The mean age of puberty of non stimulated gilts is about 200 days, with a range of 135-250 days. For stimulated gilts the variation in age at puberty is 30 to 40 days lower than for induced gilts. A restriction of feed or energy intake to 60 to 70 percent of ad libitum intake will delay the onset of puberty by about 9 days, but less severe restriction will not influence age of puberty.

Ovulation Rate

The primary constraint on litter size in swine is ovulation rate. Ovulation rate increases with successive estrous periods, and thus delaying mating until second or third estrous will increase ovulation rate and embryo survival. It has been established that increasing feed or energy intake (flushing) or restricted fed to gilts for 11 to 14 days before mating increases ovulation rate, but only to the levels achieved by ad libitum fed gilts (Table 1). Therefore, with lean gilts it is advisable to feed ad libitum from time of selection up to the time of mating.

Table 1 : Influence of flushing on ovulation rate.

Prepubertal feed (kg/d)	2.0		2.4		Ad libitum
Postpubertal feed (kg/d)	2.0	2.4	2.4	2.8	Ad libitum
1st ovulation rate	11.2			12.6	13.3
2nd ovulation rate	12.1	13.5	13.5	13.4	13.7

University of Alberta (1986).

Table 2 : Requirements for several nutrients of breeding herd replacements allowed feed ad libitum.

Intake Levels	Weight (kg)	
	Developing Gilts	
	20-50	50-110
Energy concentration (kcal ME/kg diet)	3255	3260
Crude protein (%)	16	15
Nutrient ^a		
Lysine (%)	0.80	0.70
Calcium (%)	0.65	0.55
Phosphorus, total (%)	0.55	0.45
Phosphorus, available (%)	0.28	0.20

NRC (1988)

^a Sufficient data are not available to indicate that requirements for other nutrients are different from those of growing-finishing pigs.

Table 3 : Nutrient requiremnts of breeding swine.

Composition of Diets	Bred gilts, sows, and adult boars	Lactating gilts and sows
Digestible energy (kcal/kg diet)	3,340	3,340
Metabolizable energy (kcal/kg diet)	3,210	3,210
Crude protein (%)	12	13
Requirement (% or amount kg diet)^a		
Nutrient		
Indispensable amino acids (%)		
Arginine	0.00	0.40
Histidine	0.15	0.25
Isoleucine	0.30	0.39
Leucine	0.30	0.48
Lysine	0.43	0.60
Methionine + cystine	0.23	0.36
Phenylalanine + tyrosine	0.45	0.70
Threonine	0.30	0.43
Tryptophan	0.09	0.12
Valine	0.32	0.60
Linoleic acid (%)	0.1	0.1
Mineral elements		
Calcium (%)	0.75	0.75
Phosphorus, total (%)	0.60	0.60
Phosphorus, available (%)	0.35	0.35
Sodium (%)	0.15	0.20
Chlorine (%)	0.12	0.16
Magnesium (%)	0.04	0.04
Potassium (%)	0.20	0.20
Copper (mg)	5.00	5.00
Iodine (mg)	0.14	0.14

Composition of Diets	Bred gilts, sows, and adult boars	Lactating gilts and sows
Iron (mg)	80.00	80.00
Manganese (mg)	10.00	10.00
Selenium (mg)	0.15	0.15
Zinc (mg)	50.00	50.00

NRC (1988)

^a These requirements are based upon corn-soyabean meal diets, feed intakes, and performance levels listed in Tables 6, 7, 8.

Table 4 : Vitamin requirements of breeding swine.

Composition of Diets	Bred gilts, sows, and adult boars	Lactating gilt and sows
Digestible energy(kcal/kg diet)	3,340	3,340
Metabolizable energy(Kcal/kg diet)	3,210	3,210
Crude protein (%)	12	13

Requirement (amount /kg diet)^a

Vitamin A(IU)	4,000	2,000
Vitamin D(IU)	200	200
Vitamin E(IU)	22	22
Vitamin K(menadione) (mg)	0.50	0.50
Biotin (mg)	0.20	0.20
Choline (g)	1.25	1.00
Folacin (mg)	0.30	0.30
Niacin, available (mg)	10.00	10.00
Pantothenic acid (mg)	12.00	12.00
Riboflavin (mg)	3.75	3.75
Thiamin (mg)	1.00	1.00
Vitamin B ₆ (mg)	1.00	1.00
Vitamin B ₁₂ (μg)	15.00	15.00

NRC (1988)

^a These requirements are based upon corn-soyabean meal diets, feed intakes, and performance levels listed in Table 6, 7, 8.

Table 5 : Daily energy and feed requirements of pregnant gilts and sows.

Intake and Performance Levels	Weight (kg) of Gilts and Sows at Mating ^a		
	120	140	160
Mean gestation weight (kg) ^b	142.5	162.5	182.5
Energy required (Mcal DE/day)			
Maintenance ^c	4.53	5.00	5.47
Gestation weight gain ^d	1.29	1.29	1.29
Total	5.82	6.29	6.76
Feed required/day (kg) ^e	1.8	1.9	2.0

NRC (1988)

- ^a Requirements are based on a 25-kg maternal weight gain plus 20-kg increase in weight due to the products of conception; the total weight gain is 45 kg.
- ^b Mean gestation weight is weight at mating + (total weight gain /2).
- ^c The animal's daily maintenance requirement is 110 kcal of DE/kg^{0.75}.
- ^d The gestation weight gain is 1.10 Mcal of DE/day for maternal weight gain plus 0.19 Mcal of DE/day for conceptus gain.
- ^e The feed required/day is based on a corn-soyabean meal diet containing 3.34 Mcal of DE/kg.

Table 6 : Daily energy and feed requirements of lactating gilts and sows.

Intake and Performance Levels	Weight of Lactating Gilts and Sows at Postfarrowing (kg)		
	145	165	185
Milk yield (kg)	5.0	6.25	7.5
Energy required (Mcal DE/day)			
Maintenance ^a	4.5	5.0	5.5
Milk production ^b	10.0	12.0	15.0
Total	14.5	17.5	20.5
Feed required/day (kg) ^c	4.4	5.3	6.1

NRC (1988)

^a The animal's daily maintenance requirement is 110 kcal of DE/kg ^{0.75}.

^b Milk production requires 2.0 Mcal of DE/kg of milk.

^c The feed required/day is based on a corn-soyabean meal diet containing 3.34 Mcal of DE/kg.

Table 7 : Variation in feed intake during lactation of sows fed to appetite.

Feed/d (kg) ^a	Parity			
	1	2	3	4
	% Sows			
< 3.0	8	1	3	4
3.1 - 4.0	32	7	4	4
4.1 - 5.0	45	43	32	28
5.1 - 6.0	15	41	52	54
> 6.0	0	8	9	13
Mean feed/d (kg)	4.2	5.0	5.1	5.3

Lynch (1988).

^a Barley-wheat based diets containing 3.0 Mcal DE/kg.

Table 8 : Effect of feed intake and weight gain during gestation on feed intake and weight loss in lactation.

	High	Medium	Low
Gestation			
Feed/d (kg)	2.64	2.0	1.5
Wt. gain (kg)	67	48	30
Lactation			
Feed/d (kg)	3.40	4.46	4.90
Wt. loss (kg)	30.7	15.8	3.6

Mullan (1987).

Body Composition and Reproduction

With puberty induction and ad libitum feeding, gilts may reach puberty at 80 to 90 kg with 10-12 mm of back fat. The gilts that are bred at younger ages and lighter weights with lower backfat depths have higher subsequent culling rates. It is recommended that genetically lean gilts bred at less than 120 kg liveweight are fed ad libitum during the growing-finishing period (20 to 100 kg liveweight) and up to the time of breeding. The minimum nutrient content of their diet should be that recommended by NRC (1988) and presented in Table 2. Such a feeding programme will maximize the gilts body weight and condition at time of breeding and may increase their ovulation rate, litter size and lifetime in the herd.

Gestation

Nutrient requirements and daily feed allowances recommended by National Research Council (NRC, 1988) are presented in Table 3-5. In Table 3 & 4, the requirements of a gestating sow with a mean gestation weight of 162.5 kg are shown. The basis on which the energy and feed intakes of sow at different weights were calculated is shown in Table 5. NRC (1988) suggest that a 12 % protein diet containing 3.34 Mcal DE/diet kg and 0.43 % lysine is sufficient for gestating sows and gilts. The suggested daily feed requirements range from 1.8 to 2.0 kg feed per day, depending on the weight of the sow and assuming a total weight gain during gestation of 45 kg (25 kg of maternal gain plus 20 kg increase in weight due to the products of conception). These recommended feeding level also assume individual feeding and comfortable environmental conditions. An approximate guide to feeding of a gestating sow is 1% of the sows weight (kg) plus 0.5 kg of a corn/soyabean meal diet or 0.7 kg of barley/wheat based diet. The gilts should gain 30 kg body weight in their first parity, 25 kg, in their second parity and 20 kg in each subsequent parity.

Feed intake in lactation

The nutrient and energy requirements of the lactating sow will depend on the weight of the sow, her milk yield and its composition and the target change in weight or body condition targetted for the lactation. The nutrient requirements of sows at different weights, producing average lactation milk yields are presented in tables 3, 4 and 6. The NRC (1988) suggest that daily feed intakes of 4.4 to 6.1 kg of a diet containing 13% protein and 0.6% lysine will allow the production of a average milk yields of 5 to 7kg/day without significant loss in sow weight or condition throughout lactation.

6.4 Addition of Enzymes to Improve the Utilization of Pig Feeds

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Enzymes are protein biocatalysts which are specific to one type of reaction and, like any catalyst, accelerate the reaction rate. However, unlike chemical catalysts which are generally robust and capable of being used under extreme conditions, biological catalysts require mild conditions, operate only within a relatively narrow range of temperature and pH and are rapidly inactivated when environmental conditions fall outside this range. In most industrial applications of enzymes it is possible to alter process conditions to suit the requirement of the enzyme. Unfortunately this is not possible when considering the addition of enzyme activities to the diets of pigs and other livestock. Here, unless pretreatment of the feed is envisaged, a source of enzyme activity must be found capable of operating efficiently under the conditions imposed by the host animal.

The enzyme activities most often considered as feed additives belong to a group of enzymes collectively known as the hydrolases (Table 6.4.1). Hydrolases catalyse the hydrolysis of biopolymers liberating, for example, amino acids from proteins and simple sugars from polysaccharides such as starch in a form capable of being absorbed and utilised by the animal. Both of these examples are enzymes produced by the pig and secreted into its digestive tract. In addition the hydrolases include enzymes which are not produced by farm animals themselves but are produced by the microorganisms which inhabit their digestive tract. Perhaps the most important of these are the enzymes capable of degrading plant cell walls (plant fibre). It is this group of enzymes which enable the microorganisms of the lower digestive tract to ferment the fibrous component of feeds with the production of volatile fatty acids (VFA) which in turn, are absorbed and utilised by the pig.

Table 6.4.1 : Some Hydrolase Enzymes

Hydrolase	Description
PRODUCED BY ANIMALS AND MICROORGANISMS	
Amylases	- starch degrading enzymes producing malto-dextrins and glucose.
Proteases	- break peptide bonds to produce simple peptides and amino acids.
Lipases	- fat degrading enzymes not normally requiring supplementation.

Hydrolase	Description
PRODUCED BY MICROORGANISMS	
Cellulases	- a group of enzymes which attack cellulose reducing it to glucose.
Hemicellulases	- enzymes which attack non-cellulosic carbohydrate found in plant fibre producing simple sugars such as xylose.
Pectinases	- enzymes which hydrolyse pectin, a constituent of plant fibre.

Enzyme supplementation or pretreatment of pig feeds can have a number of different aims. Enzymes can be added to pig diets to augment the animals own capacity to produce protease and amylase when it is thought that such activities are deficient (e.g. in young animals). Fibre degrading activities can be added to the feed, before or at the time of feeding, to improve both the extent of fibre degradation and the efficiency of feed conversion in animals fed high-fibre diets. Activities also can be added to destroy specific anti-nutritional factors present in a feedstuff. Each of these aims, which are separately considered below, require different enzyme activities, are appropriate to animals of different ages and are dependant on the nature of the diet fed.

Augmenting the Pigs own enzyme activities

The ability of the young animal to digest starches is of major importance in the development of milk replacers and creep foods. In the piglet, amylase activity remains low until about 3 to 4 weeks of age. During the period from the fourth week to the eighth week of life, pancreatic function and endogenous enzyme activity increases rapidly and after this period the young animal is assumed to be capable of utilising the dietary starch and protein provided. There is therefore a theoretical basis to suggest that augmenting the very young animals own capacity to produce digestive enzymes may be of some benefit. In fact, the addition of enzyme blends containing protease and amylase activities are said to be of general benefit, leading to improve live-weight gain and efficiency of feed conversion, when fed to both early-weaned and growing pigs. However there is scant evidence to support this view. In an experiment, a significant amount of feed (13.9 kg) was saved at the 0.5 g/kg enzyme application rate compared to control animals and the time taken to reach a slaughter weight of 80 kg was reduced by eight days.

Generally the addition of expensive enzymes to diets with the aim of supplementing the animals own digestive enzymes confers little benefit. Gains are small and would be cost-effective in high intensity production systems when time saved in reaching slaughter weight could be used to increase throughput. Addition of amylase and protease enzymes are very unlikely to be of benefit in less intensive systems.

Destruction of anti-nutritional factors

Initial interest in the addition of enzymes to diets of livestock stemmed from attempts to alleviate the anti-nutritional properties of some poultry feeds. This proved successful and has been adopted by many European and American poultry producers, most notably for the specific destruction of gel-forming polysaccharides found in some barley or rye-based diets which, in untreated feed, reduce nutrient utilisation and increase the incidence of sticky droppings. Similar problems are not encountered by pig producers and the addition of enzymes to overcome the effect of specific anti-nutritional factors, such as trypsin inhibitors, relevant to the pig has been little considered.

Addition of fibre-degrading enzymes

Probably the greatest opportunity for enzyme addition lies in increasing the nutritive value of feed ingredients of poor biological quality. This is of particular relevance when the nutrient density of diets is low because of the inclusion of fibrous material of poor digestibility. The scope for improvement in fibre utilisation by enzyme addition is lower in the pig than in poultry where the capacity for hindgut fermentation is much reduced. Any fibre available for degradation by added enzyme would be equally susceptible to microbial fermentation in the hindgut of the pig. Estimates of the efficiency of utilisation of carbohydrate fermented to VFA in the hindgut vary between 0.5 to 0.67 of that achieved by direct uptake.

Enzymes for the hydrolysis of plant fibre are generally marketed as "cellulase" preparations as most were developed for the hydrolysis of cellulose-rich materials. Most of these preparations also contain a variety of other enzyme activities necessary for the complete hydrolysis of cell wall material (Table 6.4.2). However it should be recognised that very few commercially available enzyme preparations have been designed as feed additives and it is purely fortuitous that several have proved moderately suitable for this purpose. Cellulase enzyme preparations are designed to maximise the release of glucose from cellulose but do not necessarily contain all of the activities necessary to ensure that the other cell wall polysaccharides are similarly reduced to single sugar units (monosaccharides). Since disaccharides (two sugar units) are poorly absorbed by the small intestine of pigs and longer chains of sugar units (oligosaccharides) are not assimilated the presence of enzymes (glycosidases)

capable of reducing all oligosaccharides to their constituent monosaccharides is essential.

The composition of plant by-products locally available for inclusion in pig diets vary considerably and may show extreme differences when compared to cereal grains or forage material. For example, palm kernel meal contains a high proportion of mannan (20%) while citrus wastes are rich in pectin. Most "cellulase" preparations lack the enzymes necessary to degrade either of these polysaccharides and enzyme

Table 6.4.2 : Enzyme activities found in three examples of commercial cellulase preparations.

ENZYME ACTIVITY	Commercial Cellulase Preparation		
	1	2	3
	Units of activity ($\mu\text{mol reducing sugar min}^{-1}\text{ml}^{-1}$)		
Cellulase (carboxymethylcellulose)	5.0	3.8	11
(avicel)	1.3	6.0	16
Mixed-linked glucanase	123	45	65
Lichenanase	19	6.6	19
Glucosidase	8.7	6.5	9.2
Xylanase	15	9.6	18
Xylosidase	2.2	1.0	0.3
β -1, 4-Galactanase	5.8	1.1	0.8
Mixed-linked galactanase	0.3	0.5	0.7
Pectinase	17	1.3	4.8
Polygalacturonase	50	3.4	8.5
Arabanase	6.4	0.8	1.3
Arabinosidase	7.0	5.2	5.2
Mannase	0	0	0
Mannosidase	0	0	0

* assayed at 40°C, pH 5.0.

addition using "cellulase" preparations would appear ineffective although both pectin and mannan are readily degraded by the appropriate enzymes.

Few research workers attempt to match the enzymes present in their preparation to the chemical composition of the diet or diet ingredient, often erroneously assuming that all necessary activities are present. It is hardly surprising that, when neither the composition of diet or the suitability of the applied enzyme mixture is considered, results from the few pig trials that have been attempted with "cellulase" preparations have proved inconclusive. While a 10% increase in feed conversion efficiency was reported when diets containing wheat, maize and soyabean or grain, lucerne meal and barley husks were supplemented with "cellulase", another diet based on beet pulp, oats, lucerne meal and maize gluten failed to show any response. Despite the rather inconclusive results obtained to date, the authors believe that enzymes can have role in improving the nutritive value of fibrous feeds. However to be cost effective it is essential to ensure that the mix of added enzymes are appropriate for the diet fed and that the way in which they are presented to the animal maximises the extent of fibre degradation.

Site of enzyme action and mode of delivery

There are a number of practical considerations relating to the physical properties of enzymes and their mode of delivery which have marked effects on the efficacy of enzyme addition. However, as local conditions and methods of pig husbandry may vary considerably it is possible only to make some general observations. In most of the animal trials to date enzymes have been added to feeds immediately prior to feeding and, thus, the bulk of enzymic hydrolysis takes place within the pig digestive tract. This requires enzymes able both to survive the low pH conditions which may be encountered in the stomach and to operate efficiently at the pH and temperatures found in the foregut. In fact most commercial enzyme products derive from relatively few strains of fungi, all which produce enzymes which broadly satisfy these requirements. Under these conditions the major constraint to efficient hydrolysis is one of time. Although the residence time of fibrous feed in the stomach may be quite long the low pH conditions found in this section of the gut inhibits enzyme action. Most of the hydrolysis that does occur is likely to take place during the approximately three hours it take for digesta to pass through the small intestine into the hindgut. Time course studies made in this laboratory have shown that hydrolysis of many feed ingredients fails to reach the maximum potential within this time. One way of overcoming this problem is to consider pretreatment of the feed or feed ingredient by adding enzymes several hours before feeding. Providing there is sufficient moisture present (at least 50% by weight) and acid pH conditions are provided (pH 5-6), hydrolysis will approach completion within 24 hours or less at ambient temperatures. However release of soluble sugars will encourage the growth of microorganisms and, in practise, it is necessary to arrive at a compromise between maximising hydrolysis and limiting the level of microbial contamination. Because of the need for moisture, enzyme pretreatment is not a practical proposition for feed compounders providing pelleted feeds. It is an option when

feeds is provided as a slurry, as is the case in many traditional methods of feed presentation and the pipe-feeding used in some highly intensive production systems.

Outlook for enzyme supplementation

Commercial enzymes, when used on the scale necessary to treat bulk feeds, are relatively expensive. Application rates vary with concentration of the preparation and the nature of the feed treated but are generally in the region of 1 to 10 kg enzyme per tonne of feed. Industrial enzymes costs are in the region of \$10-25 kg in the country of origin and would be more expensive in the absence of local supplies. For enzyme addition to be cost-effective the benefits which accrue from improved feed utilisation must be of a scale sufficient to offset the initial cost of the enzyme and its delivery to the animal and to provide an additional margin of profit for the producer. The effects of treatment must also be reliable and predictable. This is unlikely to be achieved unless enzyme formulation is matched to locally available by-products and other potential feed ingredients. This implies a need for trained enzymologists able to evaluate industrial enzyme products for their regional suitability and the availability of laboratory services and advice of the type provided by extension services to evaluate the potential of enzyme addition for the treatment of specific feed ingredients. Without this support enzymes are likely to prove a very expensive way of adding a little additional protein to pig diets.

CHAPTER VII

BREEDING AND IMPROVEMENT OF PIGS

7.1 Breeding and Selection

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In India the reasons for low productivity are manifold. The low production potential of the genotypes of indigenous breeds has been identified as one of the major causes. Therefore, programmes aimed at improving the genotypes are of paramount importance in increasing the productivity of pig population in India. The production potential of indigenous genotype breed is low, but they are well adapted to the different production systems. In recent times, the pig breeds have been selected to produce lean meat quite efficiently under improved feeding and management conditions. Genetic improvement of indigenous breeds, adapted exotic breeds and their crosses has to be carried out under existing management and feeding systems in order to produce suitable high producing genotypes for different production systems. In pig breeding programmes, attention is focused on improving two aggregate traits; reproductivity and productivity. Reproductivity refers to the number of piglets born (litter size at birth) and, therefore, the number of piglets weaned, which is primarily a function of the dam. Productive performance refers to the efficiency of meat production, which is a function of a combination of traits like growth rate, feed efficiency and carcass quality.

7.1.1 Breeds - Indigenous verses Exotic

In India four kinds of pigs are found, viz, Wild pigs, domesticated or indigenous pigs, upgraded stock of pigs and exotics. In order to raise the productivity of indigenous pig stock and thereby to obtain better meat yield, high quality breeds are imported from foreign countries such as U.K., New Zealand and Australia.

Indian Breeds

The Indian wild boar is commonly found in low jungles or forests and on the Himalayas. Generally it exceeds 136 kg in weight. Wild boars found in West Bengal are heavier than those of Punjab and Deccan. the wild pig has a long snout, short ribs and long legs. Colour of the animal is rusty grey when young and it becomes dark chestnut brown with it's hair tinged with grey at the extremities. The wild pig is a poor producer of piggery products. The meat is however delicious. Blyth is the wild boar found in the forests of the Andaman Islands. The pigmy hog is found to inhabit the moist forests at the base of the Himalayas in Sikkim,

Nepal, Bhutan and Assam. These are good for use in research as they need less housing space, eat less, are easier to handle and produce less waste (feces).

The indigenous pigs of India have come to stay as a distinct group as a result of gradual domestication of wild pigs to their surroundings. These pigs differ in their characteristics and colour from region to region within the country depending the topography and climatic conditions. The colour varies from black, brown, rusty grey to an admixture of any two colours. In size and appearance they differ considerably. They possess a long face tapering towards the nostrils. The hairs on the neck and part of the back are thick, long and bristly, while those on the sides and the flank are thinner and shorter. Head and shoulders are heavier as compared to hind quarters; back is slightly arched and rump is drooping. Ears are small and medium sized. Tail reaches nearly the hock and has a tuft of hairs. Female possess 6-12 teats. Adults pigs weigh up to 168 kg. Indigenous pigs are mostly slaughtered and consumed as fresh pork.

Exotic breeds

The Large White Yorkshire is a native breed of United Kingdom and is reported to produce better bacon when crossed with other suitable types. This breed is imported into India from U.K., New Zealand or Australia. It is large in size with a long and slightly dished face. Body is covered with fine hair, free from curls. Skin is pink coloured and is free from wrinkles with long and moderately fine coat. Ears thick long and slightly inclined forward and fringed with fine hair. Neck is long and full to the shoulder with deep and wide chest. Shoulders are not too wide. Back, is slightly arched, loin is long and broad with a well developed wide rump. Ham is fleshy extending up to the hocks. Tail is set high. Mature boars and sows of this breed generally weigh 295-408 kg and 227 - 317 kg respectively. This breed is very popular for the type of bacon obtained from it.

Middle White Yorkshire was evolved as a result of crossing Large White Yorkshire and Small White Yorkshire breeds of U.K. It is a medium size bacon pig and a good porker as light weights. It is white in colour with a short head unturned dished face wide between the ears. Neck is blended neatly from head to shoulder. Ears are nearly erect but somewhat inclined forwards. Hams are broad, and fleshy upto the hocks. It is a prolific breeder, maturing early and the sows make good mothers. Mature boars and sows of this breed generally weigh 249 - 340 kg and 181-272 kg respectively.

Berkshire is one of the oldest English breed of swine. The breed is valued as producer of quality meat, specially suitable for the pork market. This breed is used in upgrading programmes. The breed is black with white markings usually on the feet, head and tail. It has a short

head with dished face. The snout is short. The body is long and ribs well sprung. Mature boars weigh about 280 to 360 kg or more.

Landrace pig is white with lop ears, has a long side with good hams and is an excellent bacon yielder. It is a native of Denmark. It was imported into Britain in 1949, and is the second popular breed in U.K. Danish Landrace with long barral is very famous bacon breed. The pigs proved to be superior to Large White Yorkshire in carcass quality. Boars of 25 weeks of age weigh 95.5 kg.

Hampshire breed was developed in USA from hogs imported from UK in the early part of 1800. It is a black hog with a white belt encircling the body and including the front legs. Head and tail are black, and the ears are erect. The pigs are short legged. Sows are very prolific breeders. The weight of a mature boar is 300 kg and of sow 280 kg.

Tamworth is possibly the purest modern representative of the native English pig. The colour is reddish or chestnut, typically golden red hairs on a flesh coloured skin. The snout is very long and straight. The ears are fairly large rigid and incline forward. It has a strong back and thin shoulders. The carcass produces bacon of the best quality. Sows are prolific breeders. Mature boars weigh up to 300 kg.

Wessex Saddleback, an English breed is essentially a bacon breed, easily adaptable for pork production. It is known for its prolificacy and has a robust make up. Head, neck, hind quarters, hind legs and tail of this breed are black. Head is fairly long with straight snout and ears having a forward pitch without being floppy. Pigs of eight weeks of age weigh 21.5 kg.

Duroc has its origin in USA. It is red in colour, with the shades varying from a golden to very dark red. It is a large breed with excellent feeding capacity and prolificacy. The sows are good mothers. The weight of mature boar is 410 kg and sow 250 kg.

7.1.2 Breeding Objectives

Skill and care in the selection of breeding stock are essentials to success in pig breeding. There are certain qualities and characteristics to which close attention should be directed. The annual production of a sow used solely for pig meat production is assessed by the number and grades of carcasses processed from her offspring and the stock used for breeding. The assessment is done by their productivity, i.e. litter size, number of piglets weaned etc. In recent times, the present market demands a lean carcass with a minimum of fat. The important objective of the swine breeder, regardless of current local demands must be maximum efficiency of production. The factors which are of great importance should be chosen for breeding.

(i) **Number of Pigs Reared**

- (A) **Number of pigs born per litter:** About twenty or so eggs released by a sow during ovulation may be fertilized. Several of the resulting foetuses or embryos die and wither away before farrowing operation. The genetic control of litter size is very limited, because of low heritability.
- (B) **Number of litters born per year:** If early weaning of pig at three or five weeks is done, more than two litters can be achieved. Breeding record are essential to determine the ability of the sow.

(ii) **Economy of production**

- (A) **Growth rate:** The daily weight gain of a pig is a measurement of its speed or rate of growth. Genes determine the maximum rate of growth.
- (B) **Food conversion ratio:** It is closely associated with growth rate. It is the ability of the pig to convert food into meat and fat. Marked genetic variation exists between and within breeds and improvement can be realised by selection of breeding stock.

(iii) **Carcass quality**

The quality of the carcass is the end result of a growing process which not only involves the pig's overall growth rate but the comparative rates at which its bone, muscle and fat tissue develops. Genetic selection within breed has basically produced strains of pigs suitable for market requirements. All markets require minimum fat and maximum lean tissue development.

7.1.3 Breeding Systems

The breeding system of mating refers to the degree of genetic relationship between animals. The pure breed has a gene pool different from that of other breeds. Therefore, mating of two individuals from different breeds introduces in the progeny a gene combination that is different from that existing in the breed of either parent. The breeding programmes followed by producer of pure bred pigs are often different from those followed by producers of market pigs.

Crossbreeding is the mating of individuals of two breeds. In commercial swine production, most of the pig slaughtered are crossbred. The

sole purpose of crossbreeding is to take advantage of the observed improvement in performance of the progeny above the either parent. An improvement of 5 to 15 percent in growth rate, efficiency of feed conversion and reproductive traits is common in cross bred animals. The major objective of purebred swine production is to identify and propagate superior sires for use in commercial production primarily in cross breeding programs as well as to propagate and identify superior females for maintaining valuable genetic material.

Improvement in commercial swine production will be only as rapid improvement in the parent's purebreeds. Outbreeding and inbreeding both involve mating of individuals within a breed. Out breeding is the mating of individuals less closely related than the average of the breed. This is the most common type of mating in normal pure bred production in which boars are often selected on the basis of their performances or progeny testing and there is no common ancestor present for four or five generations back in the pedigree of the boar and the females with which he is mated. Inbreeding is the mating of individuals more closely related than the average of the breed. Commercial producers have frowned because usually the offspring are inferior to the parent in growth ability and in prolificacy. However, after several years of inbreeding, it is possible to obtain lines which produce uniform offspring.

The selection of breeding system might offer a means of obtaining superior performance in swine. The best approach to intensive selection within a pure breed population will provide outstanding sires for use in commercial crossbreeding programs.

7.1.4 Physical basis of selection

The changing food habits of man, the economic competition from other types of edible fats, the increasing availability of other meats such as beef and poultry and most recently the repeated assertions of a relation between animal fats and certain vascular disorders have increased the importance of the physical basis of selection.

(i) Essential carcass characteristics

The consumer demands a maximum amount of muscular tissue with a minimum of fat. It is logical to stress the selection of swine in relation to the carcass characteristics at slaughter. The carcasses of bacon are graded on weight, length and the thickness of fat. The carcass length of acceptable meat type pig slaughtered when weighing from 200-220 lbs should be from 29-31 inches. Length is not so important in pork and heavy cutter carcasses. Thickness of back fat has been recognised as an important measure of carcass quality. In the carcass quality, back fat is usually measured

at several points such as first rib, last rib, and last lumbar vertebrae. All buyers are seeking a carcass which is as lean as possible irrespective of the weight of the carcass required. The back fat is measured by back fat probe method, use of leanmeter and ultrasonic technique etc. These mechanical methods for determination of back fat thickness of the live animal are valuable to supplement visual appraisal and the use of scales in the selection of meat type breeding stock and the production of higher quality pork carcasses.

(ii) Essential performance characteristics

Factors such as litter size, mothering ability, lactation rate, growth rate and the efficiency of feed utilization are the most important in swine production. Large litter size is essential for efficient pig production. Selection for litter size has been practical for generations, to improve it by genetic means. The weaning of a large litter size indicates a high ovulation rate, absence of unusual embryonic mortality, a satisfactory mammary system and presence of good mothering ability. The animals of equal merit should always be selected from the larger litters. The number of pigs weaned and their weaning weight is certainly important in profitable pig production and is influenced by genetic makeup. Weaning weight may be influenced by vigour of the pigs, milk production and the environmental factors like feeding and management practices. The breeder must strive for low mortality and good health in suckling pigs. Post weaning growth rate and type of growth (muscle or fat) are much more highly heritable than litter size or weaning weight. The rate of gain and economy of gain are closely related. The time from birth to slaughter weight has been progressively reduced. The good type fatteners pig reaches slaughter weight of 90 kg at six months of age. Feed conversion efficiency is affected by the nature of the ration, the sex, environmental temperature, management practices and genetic make up of the pig.

(iii) Anatomical features in swine selection

The physical factors which are associated with the general appearance of the animal are responsible for carcass quality and appearance. All breeding animals should be of sufficient length of 29 to 31 inches in the progeny at slaughter weight of 90 to 100 kg. The heritability of nipple number is relatively high and is an important point in selection. The colour of pig has been an important characteristic in the development of the breeds, but is not considered as a limiting factor in efficient pig production.

(iv) **Vigour and longevity**

The ability of the newborn pig to survive, especially if the environment is unfavourable, is extremely important in profitable pig production. In the survival and longevity of swine, the role of genetic make up can not be overlooked. It also depends upon the freedom from disease, environment and managerial conditions.

7.1.5 Breeding Swine Scorecard

	<u>Perfect score</u>
GENERAL APPEARANCE	25
Type - heavy muscled, lean, trim, firm smooth long bodied ham and rump should be wider than rest of body, moderately deep uniformly arched top well balanced and stylish with a high degree of developmnt in the valuable region of the hindquarters, same standard as for the market barrow.....(12)	
Size - ample size, scale and ruggedness for age.....(13)	
CONFIRMATION	45
Hindquarters.....(26 points)	
Hind legs - set wide apart, out on the corners giving an indication of abundant muscling.....(2)	
Ham - Wide deep long, full, firm, meaty, deep in the seam..(9)	
Rump - long, wide, uniformly turned high tail setting meaty..(6)	
Loin - muscular turn, long, lean.....(8)	
Forequarters(14)	
Back - muscular turn, long, lean, uniformly, arched full spring of rib.....(7)	
Shoulders - smooth, muscular, free from fatty creases and wrinkles, no evidence of fat deposits at the elbow.....(4.5)	
Head - clean-cut, trim, firm, jowl.....(2)	
Neck - short.....(0.5)	
Middle(5 points)	

Deep, roomy middle but not loose or wasty, belly trim and firm deep ribbed.

BREEDING QUALITIES

30

Underplanning(13 points)

Legs - straight as viewed from side, front, and rear squarely set under corners of body, strong, straight toes.....(8)

Pasterns - strong, short, straight but not buckled over.....(1)

Action - free easy, unhindered walk, not stiff or 'peggy'.....(4)

Mammary system(12)

Six (6) sound nipples on a side, nipples prominent and evenly spaced, no evidence of inverted or blind teats.

Breed Character(5 points)

Head - varies with the breed, wide between the eyes, sows feminine and boars masculine.....(3)

Ears - relatively small and refined, not large and coarse thereby hindering vision, breeds having erect/ears should show no tendency for drooping. Breeds having drooping ears should show no tendency for being erect.....(2)

Total.....100

7.1.6 Genetic basis of Selection

The performance of a pig is determined both by its genetic composition and environmental factors. Growth rate, type of growth (muscle or fat), milk production and reproductive performance are affected by many pairs of genes. The known genetic principles are applied to pig production and to provide environmental condition which will allow the genes to express themselves in the most desirable manner for economic pig production.

i) General Principles of selection

The pigs are selected for many traits simultaneously. Improvement can be made only if the animal vary in the genes they posses. The selection of the pig on the basis of genetic makeup, heritability etc. plays an important role in genetic improvement.

ii) The concept of heritability

The heritability is expressed as a percentage (0 to 100 percent), or unit fraction and is an estimate of the average regression of phenotype on genotype. Heritability describes the portion of the deviation from overall average which is due to genetic causes. It tells us how effective selection will be. It is essential in making breeding plans. If the heritability of a particular characteristic is high, mass selection with a minimum of attention to pedigree, family performance or progeny testing may be successful. The heritability estimates for some economic traits in pigs are shown in Table 7.1.6.1.

Table 7.1.6.1: Heritability estimates for economic traits in Pigs.

Low heritability	Medium heritability	High heritability
1. Number of pigs farrowed.	Weight of pigs at 5-6 month of age.	Length of body, Legs.
2. Number of pigs weaned.	Growth rate (weaning to market).	Carcasses length.
3. Weight of litter at weaning.	Economy of gain.	Thickness of back fat.
4. Mortality from birth to weaning.	Killing out percentage.	Percent of ham, shoulder and cuts.

Most carcass characteristics are highly heritable, selection of superior female and male can effect immediate significant improvement of carcass quality in their offspring.

iii) Lethal effects of genes

In some cases death results from the presence of certain genes in the newborn pigs. These genes have become known as lethal genes. These are probably recessive in nature, atresia ani or closed colon, hydrocephalus, posterior paralysis, muscle contraction, certain deformities of the limb etc. These abnormalities have been identified with the genetic composition of the animal.

iv) Deleterious effects of genes

Hernias of the scrotum and abdomen are common in pigs.

Scrotal hernias are particularly undesirable. Since this trait is known to be heritable, boars having scrotal hernia are never used for breeding. Inverted nipples which prevent the pigs from suckling are also transmissible. The selection of breeding stock for large litters must be accompanied by selection for at least 10 to 12 sound mammary glands.

7.1.7 Hybrid pigs and Vigour

When two breeds of pigs are crossed, their offspring sometimes show qualities superior to either of the parent stock. This is known as hybrid vigor (heterosis) and is more often seen in characteristics which have a relatively low heritability. Pig breeders have known of the general phenomenon of hybrid vigor for a long time and many crosses between breeds are recognized as sound commercial successes. A hybrid pig should be the progeny of stock which have been specially selected for (a) improved performance within the breed and (b) ability to be crossed with other selected breeds and show a consistently high level of hybrid vigor. The aim of the production of the hybrid pig is the production of an economically growing pig with a high lean content in the carcass, i.e. a reduction in the cost per Kg. of lean meat. The production of hybrid pigs has a highly specialized business and must be accompanied by a vigorous performance testing program and the maintenance of a number of inbred lines. Boars of types not representative of recognized breeds are being produced and sold for commercial use by a number of medium to large companies.

7.1.8 Performance Testing and the Improvement of Pigs

Performance testing has been adopted to estimate the breeding value of pedigree boars. The relative breeding value of a particular boar could be assessed by comparing the performance figures of his offsprings with contemporary average figures.

Performance testing is designed to assess the potential of a young boar for siring profitable progeny. A group of profitable progeny of four pigs from the same litter, each comprising two boars, one castrate and a one gilt, are sent to the testing station. The pigs are weighed on arrival and their individual weight should be between 18 to 25 kg. The test commences when each boar weighs 27 kg and the sibs (the castrate and gilt) weigh 54 in total. The test is completed when each boar weighs 91 kg and the sibs collective weight is 165 kg. The sibs and boars are housed separately in order to record their feed consumption. Then the records are assessed to evaluate the economy of production and carcass quality. The purpose of testing the castrate and gilts are to obtain detailed carcass information, i.e. sample joints are dissected into lean, fat and bone. Additionally feed conversion efficiency, live weight gain and ultrasonically measured fat depth are recorded for each boar. The information is expressed

in a selection index as a points score for each boars. Since the boars tested are selected as above it will bring out improvements in most commercial herds.

7.1.9 Breeding for Commercial Growers

The pig breeding company provides two services; trouble free provision of male and female herd replacements and improved pig stock. They offer a stock of improved growth rate, carcass quality and reproductive characteristics. These companies test and select in their purebred nucleus herds in a similar way to pedigree breeders and in addition will cash in on hybrid vigour by presenting a crossbred female as a branded product.

The object of the commercial grower is not to become involved in the breeding of improved pigs, but merely to procure them. These improved pigs are supplied by the breeding companies in the shape of cross bred females and selected males or by provision of grandparent stock for a farm multiplication of females. These companies produce hybrid pigs for fattening purpose. In recent years, the rearing of feeder pigs have been increased by the small farmers as it is easier for them to buy pigs than maintaining a breeding herd.

Genetic improvement of pigs has played a major role in increasing out-put from Indian pig Industry, especially in the last ten years. The genetic improvement of pigs is aimed to increase the sow productivity economy of gain and carcass quality. In order to encourage the right system of breeding of pigs, for commercial characters, selection holds a key position. The attempts are made to improve the pig production in order to full-fill the present market requirements.

7.2 Breeding Plans for Improvement of Pigs

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Any improvement in livestock can be brought about by two basic ways. The first is the plan in which breeder selects the breeding stock and second is the choice of the mating system for rapid improvement. The mating system from which a breeder may choose are random mating (pure breeding), inbreeding and outbreeding, while selection may be based on the individual's own performance, pedigree estimates, progeny testing, sib testing or a combination of these informations. The breeding plan are the one which has to be used in conjunction with selection method for desired improvement under the present social frame work and the structure of animal industry, keeping in mind the needs of the public.

7.2.1 Role of breeding methods

Random mating and inbreeding as a matter of fact do not bring any change in gene frequency which is genetically responsible for bringing improvement. However inbreeding tries to reorganise different combination of desirable genes and increases the homozygosity in the population, thus making the individuals more prepotent having higher accuracy of selection. It also exposes many lethals and semi-lethals which can be eliminated through selection. While outbreeding brings about a sudden change in gene frequency resulting in sudden jump in improvement and also helps in transferring desirable gene in the population. It also provides an advantage of hybrid vigour resulting from heterosis which is exhibited by better adaptability or fitness value, survivability, faster growth, better reproduction and production performances. On the other hand inbreeding brings about a fall in fitness value and adaptability, resulting in poor performances.

7.2.2 Role of selection

The primary aim of selection is to predict as accurately as possible the breeding value (genetic worth) of animals available for breeding and use them on the basis of their prediction. What one really need is the reliable measures, of the extent, to which the breeding value of an animal is correlated with its own performance or its ancestor/progeny/sibs. One must also know how these correlation are affected by environmental variation, Mendelian sampling errors, dominance and epistatic relations among genes and differences in the number of offspring or sibs that are available for testing. Since the breeding value of an animal can not be observed directly, one has to depend on the Wright's path coefficient methods for its estimation.

7.2.3 Factors responsible for improvement

The rate of improvement expected from selection depends upon:-

- i) the selection differential i.e. the difference in performance between the selected individuals and the base population. This depends on the amount of intensity of selection applied;
- ii) the degree of heritability (h^2) or accuracy by which the animal's breeding value is estimated ($\sqrt{h^2}$) and
- iii) the average interval between generation or average age of parents when their offsprings are born.

The first two factors are positively related with the improvement while the third one is negatively. Thus higher the heritability, more will be the improvement. Therefore one also needs to findout how does the

heritability might be increased. Lush (1945) has emphasized three factors for increasing heritability. They are:-

- i) by minimizing or preventing environmental variation or correcting for these effects if they do occur.
- ii) by increasing number of records per individual so as to minimize error from random uncorrelated environmental variation and
- iii) by selection based partly on the merit of ancestors, collateral relatives and progeny test.

Thus lower will be the heritability of a character, the more is generally gained by using information on relatives in addition to individuals. If the improvement is viewed in the light of accuracy, the genetic gain per generation equals $h.i. \sqrt{G}$. This means genetic variation is also positively correlated with improvement. However there is no practical way of increasing the genetic variance except possibly through crossbreeding and to some extent by reducing the environmental variation.

Un-controlled Factors

Other factors that govern the rate of improvement through selection, are largely beyond the breeder's control, e.g. relative economic value of different traits, rate of reproduction, age when its phenotype can be measured and traits requiring sacrifice or sex limited traits. Since some of these factors may differ rather widely for different traits within the same population or for the same trait in different population, no one breeding or selection plan would be expected to be equally effective under all circumstances.

Factor of Personal Judgement

In addition to the factors just cited and variously influenced by them are factors of personal judgement that must usually be considered in order to maximize the rate of improvement from selection. Some of the more important factors are:-

1. choice of measures of individual merit;
2. amount of culling that may reasonably be done during the early stages in the animal's life;
3. optimum group size in progeny test and sib test selection;
4. choice of environment including feeding and management, and

5. optimum method of selection where the economic value of animal is measured in terms of several important characteristics.

7.2.4 Improving Swine

The primary objective of swine production is to get maximum lean meat in the form of bacon and ham. The productivity of ham and bacon per sow unit depends upon many factors like type of breed, litter size, litter weight at birth/weaning, age at slaughter weight, feed efficiency, growth and carcass trait. If these traits are improved, the total improvement per litter will take place. Therefore it is essential to know the different germ plasm available in the country and all over world in relation to these traits. Similarly as there are many different traits responsible for improvement, it is possible that many may be genetically correlated with few traits. Therefore it is also essential to know the genetic correlation among these traits so that one can identify few important characters which may be highly correlated with rest, for incorporation in selection index. As the response depends upon the accuracy, which is measured through heritability of the trait, it is essential to know the inheritance pattern of these traits. This will also help to decide which selection tool a breeder should use.

All breeds currently predominant in USA are known as "meat type". This is also true for so called "hybrid" swine which do not represent specific purebred. Historically swine breeds in USA were classified as (1) Lard type and (2) Bacon type. The so called Lard type was developed during mid and late 19th Century to meet the demand of lard. The present day Duroe, Chester White, Poland-China, Spotted swine and Herefords are all lard type. While in Europe, the Tam Worth, Yorkshire and Berkshire breeds were developed. The Tamworth and Yorkshires are of bacon type in England while the Berkshire is considered an intermediate or "Pork type". The important trait performance of different breed including indigenous type is given in Table 7.2.4.1.

The h^2 of litter size at birth, at weaning of weaning weight of the litter are lowly heritable (<0.2). While all estimates of h^2 of individual pig weights at weaning age i.e. 35-56 days of age are also low, indicating that weight at that age is largely dependent on nursing ability of sow rather than pig's own genes.

Leanness measured as back fat thickness and carcass traits are highly heritable. However the yield of carcass characters and leanness are negatively correlated. Thus it would be expected that h^2 of yield would also be atleast moderately high. Therefore it can be concluded that the litter size and litter weight could not be improved so fast, thus selection would not be so accurate. As litter size and weight are being influenced by mothering ability of dam, efforts should be made to get

Table 7.2.4.1: Popular Modern Breeds of Swine & their important qualities in relation to breeding.

Breed	Origin	Colour	Litter size	No. of prog. raised upto 154	Rate of gain	Carcass Merit
Hampshire	USA	Black White Belt	8.66	-	Av.	Excellent (Heavy Gain)
Duroc	-do-	Red	9.78	6.92	Exc. 138.9 lb	Av.
Poland China	-do-	Black White Spot	7.98 1 7.84	5.82	Bellow Av.	Good Heavy Ham
Berkshire	England	Black White	7.74	-	Av. Good	Av.
Spotted- swine	USA	Black White Spotted	8.7	6.92	139.0 lb	Good
Yorkshire	England	White	10.75	-	Fair	Av.
American Land Race	Denmark	White	9.74	-	Excel	Av.
Tamworth	England	Red	7.42	-	Below Av.	Poor
Chester White	USA	White	9.33 8.78	6.36	136.1	
Local	India	Black	6.0	4.60	Poor	Poor

good mothers for breeding through some breeding system. The only trait which can be influenced greatly by selection is the carcass trait and weight at slaughter age. Genetic correlation between rate gain and efficiency of gain are positive and medium. Thus there seems to be only three parameters which have a future for improvement in swine. They are (1) rate of gain (2) efficiency of gain (3) carcass leanness. Recent estimates of genetic correlation among all three traits are positive.

7.2.5 Effectiveness of Selection

Before taking any decision on breeding plan one should know the results of experiments on effectiveness of selection. It is reported that gain expected for any one character of importance i.e. number of progeny weaned/litter or litter weaned weight, or average weight at slaughter age (154 days) or back fat thickness are relatively small. The progress in any one generation can not be expected to be great, even if selection pressure is put only on one trait. The most of the experiment, an intensive selection resulted in some degree of inbreeding in the herd due to higher prolificacy of species. This resulted in inbreeding depression thus cancelling whatever improvement made through selection, which discourages selection. A similar discouraging item for selection comes from realization that continuous automatic selection for large litter size resulted in optimum which a sow can handle with fullest fitness. Any increase in this will result in poor fitness resulting in more mortality. Thus one can see that selection could only be effective in swine for carcass traits and the growth. However, litter size could not be improved by selection. It will require creating a new genotype dams having better mothering ability which could only be achieved through cross breeding.

7.2.6 Swine breeding system in Foreign Countries

Keeping in mind the above facts based on experimentation the commercial swine production in USA is premodinantly based on cross breeding.

Seed Stock Breeding

Seed stock herds are of male line raised for the purpose of producing boars to be used for crossbreeding in commercial herds. Intermediate seed stock producers could maintain herds of a pureline or breed and mate only enough superior females to produce replacement purebred stock. While the rest to be mated to boars of another breed or line of swine. The female crossbred offspring are being sold to commercial producers generally at weaning age. The commercial producer uses these crossbred female for mating to boars of third breed or line so as to produce three-breed cross commercial progeny to be raised for slaughter.

The crossbred sows going for commercial herd are from two breeds

or line selected for maternal character like high litter size at birth and weaning and litter weight. The boar line raised for commercial breeding can be selected for maximum growth and desired carcass character using selection index. As these characters are medium to highly heritable, the selection will be more effective. Specific three breed crossing systems are used to a considerable extent in Great Britain and to some degree by other European countries.

Hybrid Swine Breeding

Some of the large producers in USA of so called "Hybrid" Swine are developing types for use in specific crosses with specialized paternal and maternal lines or crosses. If successful, these systems will ultimately include sales of both male line and female line for commercial producer, as it is done today in poultry. To this date, in USA most producers follow some type of crisscrossing or rotational cross breeding scheme, so as to maintain hybrid vigour in females. In some cases, the plans followed are quite specific and systematic involving either a two breed criss-crossing or a three-or four-breed rotation. The reason for using this system over specific three-breed cross are:-

1. To avoid introduction of diseases through purchased commercial crossbred sows.
2. Due to additional cost of purchasing crossbred female.

Criss cross or rotational cross breeding programme requires that all the breeds used be atleast reasonably good for all round merit.

7.2.7 Swine breeding in India

India do not possess any recognized breed of swine. They are all non-descript types. However, few types are specific to the regions. The majority of Indian population (70%) are vegetarians and further among remaining non-vegetarian population there are few ethnic groups who have a restriction on consumption of pork. Therefore Indian pigs were never developed or selected for pork. With the recent industrial development and education in the country, the continuousness to animal protein requirement is growing at fast rate. This has generated the demand and interest for good quality pork/ham/bacon in the country.

For any breeding programme, the social frame work and the structure of livestock industry needs special consideration for its feasibility and success. It is a well known fact that the pig if raised for pork as commercial enterprise will compete with human feed being a monogastric animal. While the country is not in a position to divert any grain towards animal feed. Not only this, due to low conversion ratio, the requirement of grain is about 2-3 times more. There is a need to identify the area

and develop efficient marketing system before introducing any swine breeding programme in the country. Once it is done, then the breeder has to develop a dam line of pigs which has better mothering ability with average growth optimum enough being sustained by the nutrients available in the area with some additional supplementation. As the indigenous pigs has the capacity to utilize agriculture byproducts and wastes, but do not have good litter size, mothering ability and faster growth, a breeder has to develop a dam line suitable for commercial pig production. Similarly the sire line having faster growth and better carcass traits has to be identified and bred as seed stock.

Development of Dam line

Although many exotic breeds can do well under our climatic condition, it will not be desirable to introduce them at present in rural area because the rural farmer could not sustain their feeding and management. Looking to the above limitation the dam line has to be a crossbred with 50% indigenous blood. The crossing of local pigs to develop a commercial dam line, needs identification of an exotic breed having better litter size, litter weight at weaning and mothering ability. The breeds which have these qualities are Large White Yorkshire and Land Race. However Yorkshire should be preferred as Land Race has excellent growth which will demand extra energy in feed in which the country is deficient. The other points needs consideration is that country has a good experience with Yorkshire over generations hence be preferred.

The local crossed with Yorkshire will produce commercial female to be the future dams, be marketed to nearby town where the commercial stock breeder are located. Care must be taken only to generate required number of crossbreds which can be marketed at weaning age, otherwise the farmer has to bear a loss. The crossbred males marketed has to be raised by commercial breeder upto slaughter age only and be disposed as there will be different sire line for commercial dams.

Development of Sire line

The male line should be pure exotic having faster gain and better carcass traits. Therefore these must be located in towns as seed stock. These seed stock will be bred for future breeding boars based on selection for faster gain and better carcass trait using selection index. The breeds of choice will be American Land Race or Spotted Swine or Duroc. The males will be marketed to commercial producer, who will met them to the crossbred dam to produce 3-breed cross commercial piglets. The females of the seed stock for sire line will be selected on the basis of number farrowed and number weaned to be used for future mating in each generation, while the rest females will be sold for slaughter.

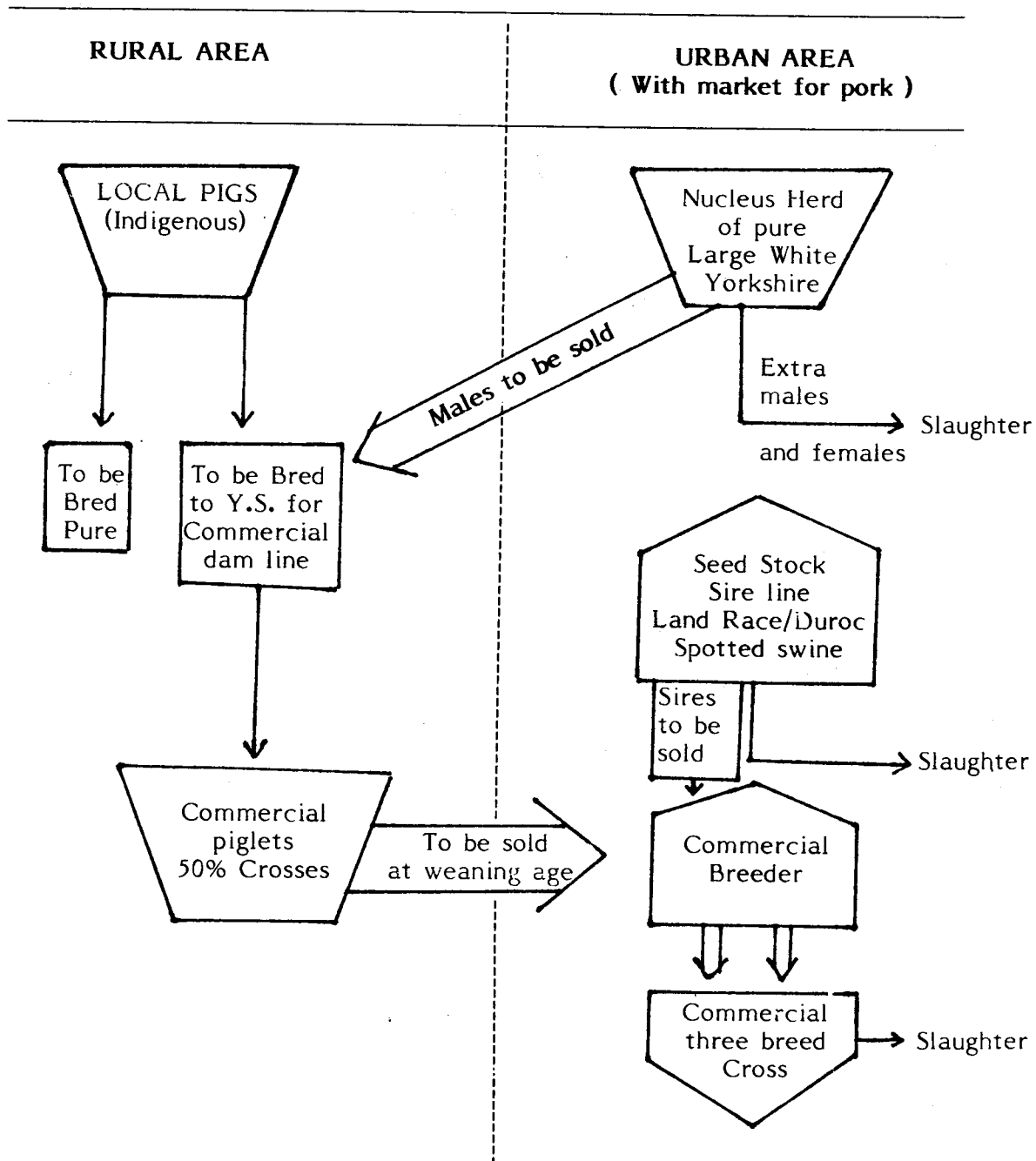


Fig. 7.2.7.1 : Proposed Swine Breeding Plan for the country.

Thus the rural area should only breed indigenous female to exotic Yorkshire sufficient enough to meet the commercial dam requirement of Urban area. The rest must be bred to indigenous only. While the Urban area where the market for slaughter is available have seed stock breeder for male line and the commercial breeder for three-breed cross commercial pig production. The detailed plan is given in Fig. 7.2.7.1.

This plan will fit well under our condition as it does not require progeny testing or planned breeding or selective breeding in rural area. Not only this, there is no need for even identification as all the crossbred pigs generated by Yorkshire crossing will identify itself with white colour which can be sold to commercial producer.

The Urban area also, where all technical knowhow can be made easily available, will be raising limited number of exotic pigs as seed stock for generating the male line. The rest of the farmer will be going for commercial production which do not require any breeding plan or any recording of data.

CHAPTER VIII

REPRODUCTION AND ARTIFICIAL INSEMINATION

8.1 Anatomy and Physiology of Reproduction

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The pig is potentially a very fertile and fast growing species, but in many parts of the country it has a poor reproductive performance and a slow growth rate. It is due to poor genetic endowment of indigenous pigs and by inadequate management under the extensive conditions of subsistence farming. A high reproductive performance is essential for a successful pig enterprise. The knowledge of the normal anatomy and physiology of the female and male reproductive tract is fundamental to the achievement of a high reproductive rate of pigs.

Female Genital system

The sow is truly polyoestrous. The puberty in sow is attained at six to eight months of age. The usual age at first service is eight to ten months. The sows can be bred round the year. The average duration of oestrous cycle is 21 days. The oestrous lasts for 40-60 hours. Ovulation commences 38-42 hours after the start of oestrous and about 20 or more ova are released. The average duration of gestation is 114 days.

The reproductive tract of the sow includes the ovaries, oviducts, uterus, cervix, vagina and external genitalia. The ovaries are oval in shape but in maturity having a mulberry like appearance due to multiple follicles and/or corpora lutea. These are enclosed in a 'purse' of peritoneum. The uterine body is short but the uterine horns are long and convoluted, measuring upto 1.5 m in pregnant animals. The cervix is poorly defined, being characterized by a thickened wall with the vagina. The vagina is 7.5 to 11.5 cm long, smaller in diameter with a thick muscular coat. The vulval labiae are thick and covered with a wrinkled integument. The vestibule is fairly long and vestibular glands are small in number. (Fig 8.1.1)

Male Genital System

In boar full sexual maturity is attained at 9 to 10 months of age. Sexually mature boar produces 200-450 ml of semen per ejaculate. Boar's semen is dilute, containing about 50,000 - 60,000 sperm in each ejaculation.

The reproductive system of the boar consists of testicles, ductus deferens, seminal vesicles, prostate gland, bulbourethral gland, urethra

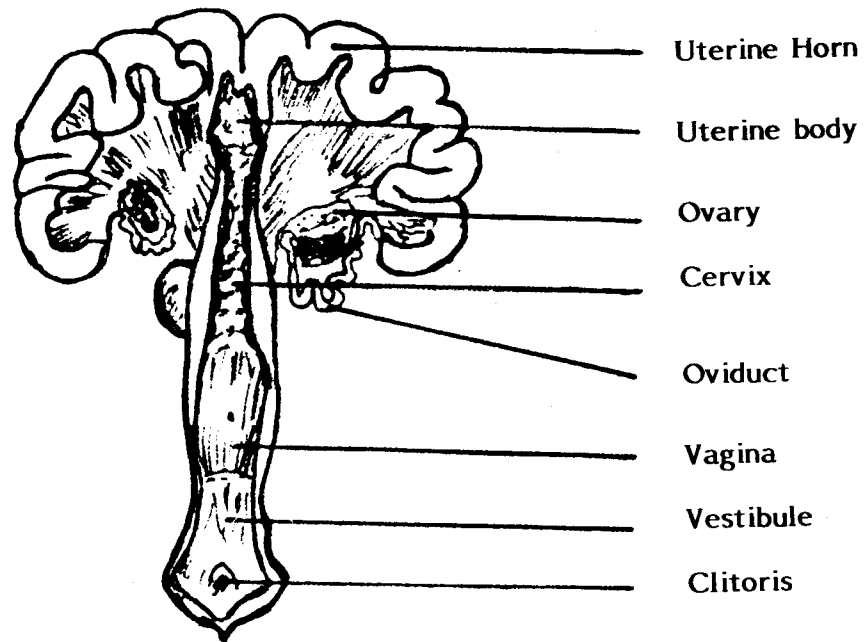


Fig. 8.1.1 Genital organs of the sow.

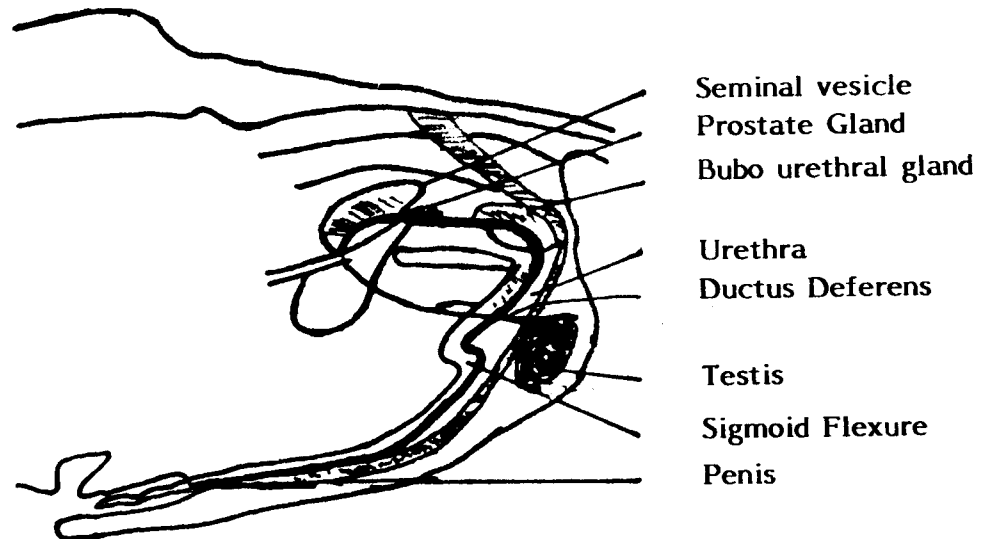


Fig. 8.1.2 Genital organs of the boar.

and penis. The testes are suspended outside the body cavity in the scrotum. The testicles are oval in shape and weigh between 500-800 gm. Within each testis there are thousands of coiled tubules called the seminiferous tubules, which produce spermatozoa by spermatogenesis. It is also a source of the male sex hormone, testosterone, which is responsible for the sexual behaviour of the boar. The spermatozoa pass from the tubules into a coiled tube attached to the rear of the testicle called epididymis. The spermatozoa are stored for a short period in the epididymis, where they mature and then they pass into the ductus deferens, which is a duct leading back into the body cavity and connects to the urethra. The bulbourethral glands are large cylinder shaped structures which lie partially over the pelvic urethra. The seminal vesicles are large, lobulated pyramid shaped structure, extending cranially over the pelvic brim into the abdominal cavity. The prostate gland has a large body, which covers the junction of the neck of the bladder and urethra. The penis is 45 to 55 cm in length and the cranial portion of the penis has no glans but is spirally twisted counter-clockwise. The integument is smooth, pale pink in colour and moist. The penis becomes erect, protudes from the prepuce before intromission and shows characteristic spiral movements. The spiralled erect penis engages the cervical canal and becomes locked in to the folds (Fig 8.1.2).

8.2 Heat detection, mating and pregnancy in sows

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As someone said, the sow has one commercial purpose in life which is to produce weaners, and the more efficiently she does this, the higher will be the profit margin on any pig enterprise. Therefore, we must pay much attention to the main phrases of sow's reproduction: heat detection, mating and pregnancy, in order to realize the maximum performance in sows.

8.2.1 Heat Detection

8.2.1.1 Puberty in the gilt

Puberty may be defined as that phase which links immaturity and maturity, recognized in the gilt by the occurrence of the first oestrous period, i.e. when she ovulates for the first time. This first oestrous is almost invariably fertile and hence represents the beginning of reproductive capability in the gilt.

Puberty may occur when the gilt is 4 - 9 months of age. Variation is attributable to genetic differences such as those of breed or cross-breeding. Feeding regime and, thereby, nutritional status, housing or stocking density, and the presence or absence of a mature male all influence the onset of puberty.

In order to induce earlier puberty in gilts of the appropriate age, producers should expose them to the stimuli such as transportation or transfer to new accommodation, mixing with strange gilts and contact with mature boar.

8.2.12 The oestrous cycle

Oestrous is seen as sexual cyclic activity in the females which are not exposed to a male or artificially inseminated after puberty. Pigs are usually polyoestrous and show cycles throughout the year. The expected length of the oestrous cycle is 21 days, with 18 to 24 days considered within the normal range.

Oestrous is characterized by a series of gradual behavioral and physiological signs. The important signs are as followings:

- Swelling and reddening of the vulva (usually but not always noticeable).
- The pricking of the ears in prick-eared breeds.
- Mounting of other females or allowing themselves to be mounted.

Showing interest in the boar and the standing reflex, i.e. adoption of an immobile posture when pressure is applied to the back. At the start and towards the end of oestrous, the sow will show the standing reflex only in the presence of a boar. For a period at the height of oestrous, however, many sows will show the standing reflex when pressure is applied on the back when the boar is absent.

- By a characteristic grunt or "roar" associated with heat.

Lactational anoestrous is a major obstacle to maximization of reproductive efficiency in swine. Some attempts have been made in recent years to break the lactational anoestrus by husbandry modifications such as grouping sows and litters about three weeks after farrowing, reduction in the number of pigs per litter, increasing the interval between nursings, boosting feed intakes and running a boar. Response to these treatments is variable so that the technique of "sow service in lactation" cannot yet be recommended for practical application.

8.2.13 Methods for heat detection

- Observation of external genitalia. Increased sexual activity and excitement are observed and vulval swelling becomes conspicuous in sows during the oestrous. So oestrous sows may be detected according to the changes of external genitalia

- ° Standing reflex to back pressure. The standing reflex is the most foolproof sign of heat. Those that are in oestrous will respond to pressure on the back, especially in the presence of a mature boar, by immobility, arching of the back, and pricking of the ears. This method is very useful in practice.
- ° Use of the "boar smell" factors. The "boar smell" factors which could make oestrous signs of sows clearly expressed are the pheromones produced in the submaxillary or preputial glands. The chemical androstenol had now been synthesised and is available commercially in aerosol form. A spray of this material is useful when no boar is available to increase detection rate in sows. This technique may be more effective if recording of boar's wooing grunt is played back in sow's shed.

It must be kept in mind that perhaps about 90% of heats can be detected fairly readily, the remaining 10% may be more difficult to detect. Thus, a dedicated and observant stockperson with adequate time available is required if high oestrous detection rates are to be achieved.

8.2.2 Mating

8.2.2.1 Timing of mating or insemination

Depending on the system of farming, sows are bred by handmating or artificial insemination. Mating or insemination very early or very late in heat results in lower conception rate and litter size. The optimum timing of service at which both conception rate and litter size are maximised appears to be 10 to 20 hours before ovulation. This timing ensures that sperm and eggs arrive fresh at the same

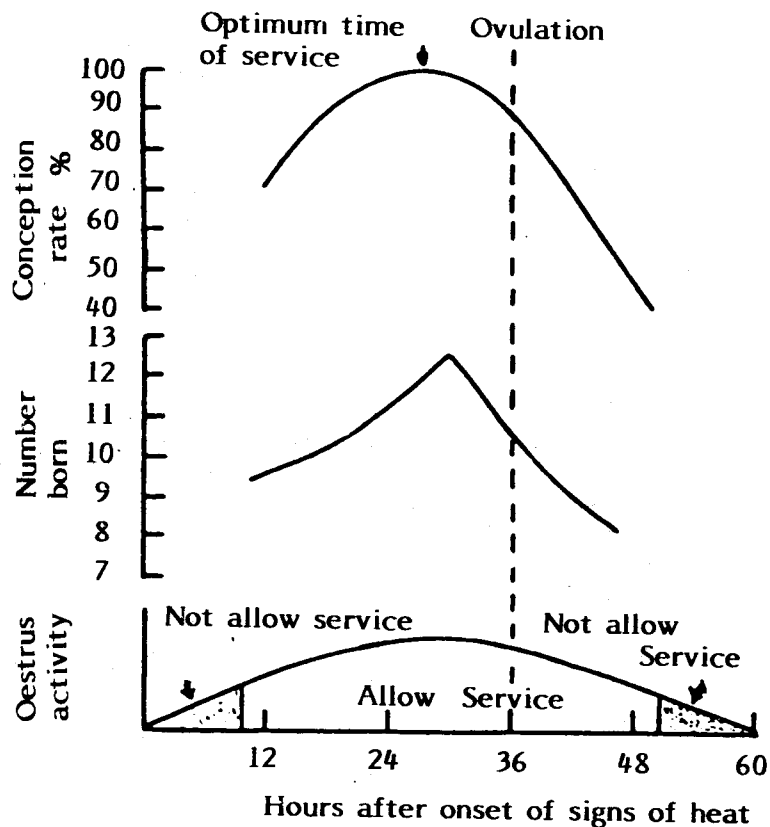


Fig. 1 Stages in heat and optimum time of service.

time at the site of fertilisation. The importance of optimum timing of service during the heat period is illustrated in Figure 1.

8.2.2.2 Service behaviour

If gilts or sows are approached for insemination earlier than optimum timing, the following behaviour will occur:

- Walking around inseminator and smelling his legs when he comes into the pigsty.
- Hyperemia of vulva.
- Avoiding to be inseminated.
- Growling and mounting or riding more than one day after service.

If the female is bred later than the optimum time, it could attract to the inseminator when he is in the pigsty. She will not allow service. Vulva feels cold. There are no more growling, mounting or riding in the females.

If mating or insemination takes place in the optimum timing, the following behaviour will be seen:

- Standing to back pressure, arching of the back and pricking of the ears.
- Drawing deep breathes when a few drops of semen are put in the tip of her nose.
- Immobility when touching vulva and mating or inseminating.
- Easily introducing of the spirally-tipped catheter along the vagina and into the cervical ridges.
- Abdominal vibrating when breeding takes place.

8.2.2.3 Types of service

- Single service. It means that the female is bred by one time using one boar's semen during oestrous. Its efficiency depends on the identification of optimum timing for service.
- Double service. During the oestrous, breeding is made two times during 8 - 10 hours. Some experimental results showed that proportion of sows failing to conceive to first service was doubled as a result of single relative to double service while litter size was also increased by double service.

- Multiple service. Oestrus female is bred more than three times during the period. Clearly, arranging triple or quadruple service is more time and labour-consuming and more demanding on boars. But for producers with a low litter size problem, it is on way of trying to improve the situation and getting a useful boost in conception rate at the same time.
- Double mating. This is a method that the females are mated or inseminated by boars' semen of two breeds during 5 - 10 minutes. Higher conception rate and larger litter size may result from this breeding system.

Also, lasting time of insemination may affect the conception rate. In general, 5-6 min. is suitable.

8.2.3 Pregnancy

8.2.3.1 Pregnancy diagnosis

The objective of pregnancy diagnosis carried out from about three weeks after service is to isolate the unproductive animal at an early stage so that she can be stimulated to rebreed or be culled as the occasion demands. The main methods available are as follows:

- Vaginal biopsy. The removal of a very small sample of vaginal epithelium with a simple scraping device is the basis of a pregnancy test in pigs, applicable from about 18 days after service up to term. The number of epithelial cell layers is conspicuously reduced in sows that have conceived. The test confirms pregnancy with 90 to 100% accuracy, while confirmation of barrenness is only about 75% accurate, on average.
- Blood progesterone level. A blood sample is taken 17 to 24 days after service and the plasma progesterone concentration is assessed. The test confirms pregnancy with 92 to 97% accuracy. Confirmation of barren animals can be 95% accurate.
- Blood oestrogens. The test can be carried out between 20 days and term but best results are obtainable by blood sampling 20 to 30 days after service. Estimation of blood oestrone or oestrone sulphate levels at this stage can confirm either pregnancy or barrenness with over 95% accuracy.
- Palpation. Palpation through the rectal wall for enlarged uterine arteries is possible in sows after day 45 of gestation, whereas changes in the pulsation response of these arteries to digital pressure - resulting in vibration or fremitus -

will reveal pregnancy from day 30 onwards. Palpations are eased if food and water are withheld for 12 hrs. before the examination, but experience and care are still essential.

- Ultrasonic scanning. This method is detection of a gravid uterus by means of a probe that transmits and receives a narrow ultrasonic beam. It is accurate from the fifth week of gestation in pigs.

8.2.3.2 How to avoid embryonic losses

The main steps which should be taken to minimise embryonic losses are the following:

- Take all possible steps to minimise risk of introducing disease.
- Ensure optimum timing and frequency of service.
- Avoid excessive food intake after service as this is associated with losses of embryos.
- Avoid excessive environmental temperature in early pregnancy as this can increase losses of embryos.
- Avoid imposing undue stress on sows in early pregnancy. The more peaceful and contented they are in early pregnancy, the lower the embryonic losses.
- Adopt a crossbreeding policy since crossbred sows suffer fewer embryonic losses than purebreds.
- Avoid very early weaning since it has been demonstrated that embryonic losses increase with earlier weaning. It is suggested that the earliest weaning time is somewhere between 18 and 24 days after farrowing.

8.2.3.3 Feeding strategies for pregnant females

In general, there are three practical feeding strategies for pregnant sows.

The first strategy is that high-low-high concentrates in diet are used respectively during periods from beginning of pregnancy to 40 days, from 40 to 80 days and 80 to parturition. This is suitable to sows that have bad body conditions.

The second strategy means that concentrates in diet are gradually increased with days of pregnancy. This method can be useful to gilts that are in growth.

The third strategy is suitable to sows that have good body conditions, i.e. only in later period of pregnancy, these sows are given rations which consist of high energy.

The following points must be paid attention to:

- ° In early and middle period of pregnancy, sows and gilts must be given a number of green forages and roughages in their rations.
- ° Pregnant females must be supplied with enough protein and mineral content.
- ° Volume of rations must be correspond to feed intake of the pregnant females.

8.3 PREGNANCY DIAGNOSIS

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The diagnosis of pregnancy in the pig has become an integral part of all modern swine production units in order to facilitate rebreeding or the culling nonpregnant sows. An efficient pregnancy diagnosis program commences with the detection of open (not pregnant) sows and is followed by a test to confirm that sows are pregnant. The pregnancy diagnosis program, in addition to identifying nonpregnant sows, also monitors the overall management of the herd. Under good management conditions, without pregnancy testing, about 10% of the mated sows will not farrow. With pregnancy testing, and rebreeding or culling of the open sows, the number of open sows at the expected time of farrowing will be reduced to less than 3%. In addition, if the number of nonpregnant sows is greater than 10%, the pregnancy diagnosis program will aid greatly in identifying the nature of the reproductive problem.

When selecting a pregnancy diagnosis program, consideration must be given to the size of the herd, the level of management and the available labour. Swine units can be classified as small holdings, family-owned and operated units, managed units with skilled labour, and managed units with unskilled labour. In the small holding, the swine herd is a minor portion of a farm operation and a simplified pregnancy testing procedure is often utilized. For these small holdings, pregnancy diagnosis programs are of limited value. In family-owned - and operated units, the family provides essentially all of the labour with considerable flexibility in the program. In managed units, the majority of the labour is hired and thus a more rigid management program is required. When the labour is skilled, the pregnancy diagnosis program may be relatively complex and similar to that utilized in the family-owned and operated unit. In contrast, when the labour is unskilled a simplified approach to pregnancy diagnosis must be undertaken. In all cases the manager must determine if the added

cost will increase profit.

Detecting the nonpregnant sow

The detection of open sows is most effective when the results are known by the time of the next expected estrus, as this allows for the immediate rebreeding of the sow. When the sow is not detected in estrus, it is assumed that she is pregnant. Procedures that can be used in this respect include estrus detection, vaginal biopsy, and blood progesterone concentration.

Estrus detection after mating is probably the easiest method of detecting nonpregnant sows. The most common testing procedure involves the use of a boar to detect the sow in estrus. In general, taking the sow to the boar's pen is a more effective means of detecting a sow in estrus than taking the boar to a pen of sows. However, a trained boar that is accustomed to checking sows for estrus in a group pen is equally as effective and will require considerably less time per sow checked. In the presence of a boar, a sow in estrus will assume a 'standing reflex' posture and will allow intromission by the boar. Back pressure alone or in conjunction with boar odor, boar sounds, or a boar in an adjacent pen also may induce the standing reflex, although they are not as effective as the boar. The use of the boar to detect sows in estrus is relatively efficient, as the sows only need to be checked from 18 to 25 days after mating.

Two alternatives to estrus detection are the determination of the concentration of progesterone in a blood sample and the vaginal biopsy technique. A 1 ml blood sample for progesterone analysis is collected between 18 to 25 days after mating. With a low blood progesterone concentration (< 5 ng/ml), the sow is not pregnant and she should be in estrus within 5 days. A higher progesterone concentration indicates that the corpora lutea are still functional and thus assumes that the sow is pregnant. Similarly, the vaginal biopsy technique can be performed over the same time interval with the results based on the thickness of the vaginal epithelium. A cell depth of > 3 epithelial cells indicates that the sow is not pregnant. The main advantage of these procedures over routine checking for estrus is that it only needs to be done on one day. However, the sow must be restrained in order to obtain the blood or tissue sample and the sample must be sent to a laboratory for analysis. The results should be available within 24 hours after the laboratory receives the sample, but may not be available until after the sow has been in estrus.

The main objective of the postmating estrus detection program is to detect the sow in estrus so that she can be rebred. The selection of a specific test procedure is dependent on the type of swine production unit. For the small holding, the farmer may not even own a boar and thus be limited to the use of the back pressure test. For the large production units, the use of boar has already been used to detect the sow in estrus.

and the mated sows usually remain in the same facility for about 4 weeks after mating. Sows that return after 25 days are either abnormal or indicate a management or disease problem. These sows should probably be culled. In managed units with skilled labour and supply of boars (breeding by artificial insemination), the blood progesterone and vaginal biopsy techniques are possible alternatives. The cost of undertaking either of these procedures must be weighed against the alternative of not detecting the open sows until after the next estrus. The labour involved in the use of the boar to detect sows in estrus after 25 days is high relative to the number of sows that will be open, and there are more efficient methods of confirming that the sow is pregnant.

Confirmation of Pregnancy

The pregnancy confirmation test looks for the presence of the products of conception and, with negative results, assumes that the sow is not pregnant. These procedures identify the products of conception either directly or indirectly and include: ultrasonic analysis; blood, urinary or fecal estrogen concentration; and rectal palpation. While pregnancy is confirmed at the time of the test, there is no guarantee that the sow will farrow. However, except for disease conditions, the incidence of pregnancy failure is extremely low and not worth the cost of time to find the occasional nonpregnant sow.

Ultrasonic analysis is probably the most efficient method of confirming pregnancy in sows. This procedure utilizes detection of the foetal heart rate and pulse (Doppler ultrasound), detection of foetal fluids in the uterus (A-mode or amplitude-depth ultrasound) or ultrasonic imaging (B-mode or echography). These three techniques are effective after 30, 25 and 20 days postmating, respectively. For all three techniques, the sow must be restrained to permit the proper alignment of the transducer in order to detect the sound (foetal pulse), the desired echo (foetal fluid) or the ultrasonic image (embryo). The accuracy of ultrasonic pregnancy diagnosis is limited by the ability of the operator to properly align the transducer towards the uterus. For the Doppler technique, the operator also must be able to identify the foetal pulse. For the A-mode transducer, a fluid-filled bladder could produce a false positive result. For the ultrasonic image, the operator must be able to identify the fluid around the embryo or fetus. An experienced operator can check an animal within 2 minutes. In order to minimize the number of open days, sows should be checked as early as conveniently possible after mating. Animals with negative results should be checked a second time within 1 week. These three techniques will detect all sows that are not pregnant at the time of testing. Thus, ultrasonic analysis is an excellent method of detecting those open sows that are not observed in estrus by the day they are checked, but sows with late embryonic death may not be detected. In addition, these procedures may also indicate sows that will have small litters.

The determination of estrogen concentration has the potential to become an alternative to the ultrasonic pregnancy test. The on-farm portion of these tests is relatively simple and best done between 25 and 30 days after mating with the collection of a blood, urine or feces sample and the shipment of this sample to a laboratory for analysis. Results should be available from the laboratory within 24 hours of receipt of the sample. However, until simplified assay techniques for on-farm analysis are available, the cost of conducting the assays cannot compete with on-farm ultrasonic testing.

Rectal palpation also has been used to diagnose pregnancy, but is limited by the size of the pubic symphysis and thus the size of the animal, as well as the size of the palpator's hand. The hand is passed through the anal ring at least 30 cm and the cervix found. The external iliac and middle uterine arteries are found and their size determined. During the estrous cycle, the middle uterine artery is less than one half the size of the external iliac artery. After 30 days of pregnancy, both arteries are about the same size (1 cm diameter). Also, during pregnancy, the middle uterine artery has a distinct fremitus (vibration during palpation). With practice, the accuracy of diagnosing pregnant and nonpregnant sows approaches 100%. For large herds, the time and labour involved would probably make rectal palpation impractical. However, for a few sows in small holdings (i.e. 1 to 20 sows) where the cost of an ultrasonic probe exceeds its value, rectal palpation could be the method of choice.

Conclusions

A variety of techniques have been developed for the detection of nonpregnant sows and the confirmation of pregnancy. In addition to identifying sows to be rebred or culled, these procedures also effectively monitor the reproductive performance of the herd and identify any potential or real problem areas. One of the most efficient programs is the use of a boar to detect sows that return to estrus after mating (18 to 25 days) followed by an ultrasonic probe (25 to 35 days) to confirm pregnancy.

8.4 SOW REPRODUCTION AND MANAGEMENT

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The successful throughput of all breeding females in the various parts of the modern pig unit depends largely on the success in getting females served in a steady flow from one month to the next. Although this may sound easy when a constant number of sows are weaned each week and a constant number of gilt replacements are selected each week, in practice the supply of served females is often highly unpredictable. There are many reasons of course but in the past as systems have evolved farmers did not invest in specialised accommodation for animals at service.

Now the situation is changing rapidly and an increasing number of pig units have purpose-built service areas. In the past also the criteria for the design of efficient service areas were not well understood but with a combination of sound practical principles and scientific effort this situation is being resolved.

One subject area which has received little attention until recently is the effect of stress at mating on general performance. When a sow is weaned particularly with early-weaning, she must ostensibly be under considerable stress. Within 4 to 7 days of weaning the sow is subjected to the attentions of a large stock boar and hopefully mating takes place. This also must represent considerable stress to the animal despite the fact that the process is a normal biological function.

It is believed that stress in some circumstances can have positive effects in terms of reproductive performance and specifically in gilts part of the 'boar-exposure' phenomenon is due to a stress component. It is usually supposed that somewhere between the extremes is an optimum exposure to stress which is beneficial to the animals reproduction.

Pheromones and service

There has been considerable research in the last 10 years in pig pheromones. This is partly due to the fact that the pigs olfactory processes are significantly more sensitive than other species (even dogs) and also due to the practical consequences of utilising pig pheromones to stimulate reproduction. The Leeds University pig research group have had a big involvement in this work and have experimentally attempted to separate out the effects of the various stimuli which are responsible for the control of oestrus and ovulation in gilts. These factors are: visual signals, tactile contact, auditory cues and olfaction. In Table 8.4.1 are presented data which show the importance of the sense of smell in pig reproduction. Bulbectomised gilts had their olfactory tissue removed surgically and when these gilts were exposed to boars the time at which puberty was attained was the same as gilts given no boar contact at all. This experiment highlights the value of boar contact and the necessity to design service areas allowing for maximum exposure of gilts and sows to male pheromones (air-borne hormones).

Table 8.4.1 Olfaction and puberty in gilts

Treatment	Age at puberty (days)
Bulbectomised Boar exposed	229
Boar exposed Sham operated	204

Treatment	Age at puberty (days)
Boar exposed	207
Controls No boar exposure	234

Source: Kirkwood, Forbes and Hughes 1981

It has also been shown that mature boars over 2 years of age are much better pheromone producers than young boars. It is therefore of little use using a young boar as a 'teaser' boar before his normal working life begins and the older smelly boars are the best for the induction of puberty.

It also seems important to allow gilts boar contact on social grounds as well as for pheromonal reasons. Table 8.4.2 shows the mating rate for gilts either allowed boar contact before puberty or not. Mating rate is defined as the percentage of gilts which are in heat which can actually be mated. The results demonstrate that gilts with previous experience of boars are much easier to serve when they are in heat and the mating rate rises accordingly.

Table 8.4.2 The influence of pre-mating boar contact on mating rate in the gilt

	Mating rate %
Gilts with previous boar experience	90
Gilts with no previous boar experience	64

Hughes and Cole 1978

An interesting extension of this phenomenon has been reported by the research group in Werribee, Australia. They have shown that social isolation from an early age (10 kg liveweight) can have dramatic effects on libido in boars and the mating behaviour of sows and gilts. Social deprivation in early life depresses libido significantly.

Another perennial question which is asked in relation to the operator of service areas is when to mate. For some years double matings in the period of oestrus have been used to maximise the chance of mating at exactly the correct time. Without doubt this gives good results on many farms but on some farms where the physiological events around ovulation are variable, poor conception results. Ovulation occurs at about

40 hours after the onset of oestrus and the optimum time to mate is 10 hours prior to ovulation so that sperm cells are ready to fertilise the female eggs immediately. Any mis-timing of this process and conception rates will fall. This means that the best time to mate is about 30 hours after the onset of heat but in practical terms we do not know exactly when this is. The answer is in well organised and frequent heat detection and perhaps a move to at least triple inseminations.

Another critical factor in the management of service areas is how females are handled in early pregnancy. My view is that females should not be moved from the service area until 4 weeks after service. This allows for a check on the returns to service which occur at about 3 weeks after the initial mating. It also helps to minimise the amount of stress that sows and gilts are exposed to in an absolutely crucial stage of pregnancy. In the first 3 weeks of pregnancy the fertilised eggs are making the delicate attachment to the lining of the uterus and any disturbances to the dam will cause hormonal upsets which increase the number of eggs rejected by the uterine lining in the same way that tissue transplants in humans are immunologically rejected. Leaving the sows in the same accommodation for 4 weeks after service allows the maximum development of viable eggs for all sows.

This problem of embryo loss is similar to what happens when we apply very early-weaning. Early weaning appears to induce disturbed hormonal profiles in a high proportion of sows and in particular the steroid hormone group, the oestrogens are adversely affected. This therefore may represent another manifestation of chronic stress. With early-weaning we are compressing together two major stressors; parturition and weaning and the net effect is responsible for reduced embryo survival and a smaller litter size. It may ultimately be possible to manipulate this effect with exogenous hormones but right now the advice not to wean too early is good advice. In relation to the question of when to wean for optimum production, most people still believe that 3 weeks is the best. This conclusion is based on work done in the 1970's when the economic climate was significantly different from that prevailing now. We have all made the basic assumption that if we maximise our annual sow productivity then we will maximise our financial success. This may not always follow and a recent computer study has shown that the optimum time to wean will change over a medium time-span. In the current situation where feed prices are high compared to the prices we receive for both weaner pigs and bacon pigs then it is hard to justify weaning at less than 5 weeks of age!

Man-animal interactions

There is still enormous variation both within and between farms in the level of prolificacy experienced. Some of this variation can be explained away by factors already mentioned such as poor service management and early-weaning. There are also factors such as nutrition and

seasonal influences which govern the expression of litter size. Despite this, it is hard in practice to explain the large differences between what appear to be similar farms with similar pigs. An interesting survey/experiment has recently been carried out in Australia where the responses of sows to humans were evaluated by experts in animal behaviour. On farms where the sows obviously exhibited strong aversion to humans there was a generally depressed reproductive performance in terms of ability to conceive and also litter size. Conversely on farms where sows showed a good affinity with humans then the level of reproduction was enhanced. This is a very important observation and may tell us a lot about the variations in prolificacy. The experiment needs repeating under European and North American conditions to test its applicability to other production methods. It does point to the fact that if selected gilts are handled correctly and carefully in early life and at puberty and throughout mature working life then it pays in financial terms as well as in animal welfare terms.

Stress is a notoriously difficult concept to evaluate in terms of its effects on animals and on the production of animal products. It is well established however that stress does profoundly affect the biology of pigs and the outcome of high-stress systems is reduced productive efficiency.

In particular, reproductive performance is adversely affected by varying stress levels and this manifests itself as reduced litter size, failure to show oestrus, poor conception rates and sporadic puberty attainment. There is certainly a need for a great deal more research into the relationships between stress and reproduction but there is enough published information now to give some guidelines for the commercial farmer to follow.

Stressors or the factors causing stress in sows and gilts come in a variety of guises. Nutritional stress is perhaps one of the easiest to define and over or under nutrition can be judged against published and well known nutrient requirements. Social stressors are more difficult to understand but things like overcrowding with both high stocking densities and large group sizes are best to avoid. Other stressors for pigs stem from relocation, mixing, environmental temperature and a whole host of management factors related to the system of production. One of the most important stressors may come from the man-animal interactions which exist on individual farms. On some farms the level of stockmanship could be very high indeed and all animals are well cared for as individuals. On other farms there may be nothing wrong with the overall system of production but because of aberrant interactions between the animals and the people involved with the animals, the animals could be faced with considerable stress in their lives.

At the present time it is hard to pinpoint the danger signs of

stress on a pig farm. Non-specific poor reproductive performance is one of the signs but it is not always easy to allocate the blame. Other signs are stereotypicism or displacement activity. These behaviour patterns in pigs are seen outwardly as 'bar-biting' and as vices such as tail-biting in young pigs. In older animals, it could also reflect hyper-aggressive behaviour or poor maternal instinct.

There seem to be particular times in the normal reproductive life of sows when they are especially prone to stress. These are during the major events such as puberty, weaning, parturition and mating. At these critical stages perhaps animals should be treated extra carefully. It is pleasing however that there are now a number of research projects being carried out in different corners of the world on the effects of stress although the impetus for this work has been the increasing public conscience about animal welfare. What is encouraging is that good welfare goes hand in hand with a high level of productivity and so by considering the welfare of their animals (which of course farmers have always done) pig producers could also increase their efficiency and hence their profits.

In physiological terms the connections between stress and reproduction are becoming much better understood. Stress is known to elevate the blood hormone cortisol and this leads to a cascade of events culminating in the formation of cystic ovaries. This shows how via the disruption of hormonal events stress can modify the animals ability to have normal oestrus periods and also alter the ovulation rates and the ability of fertilised eggs to survive the first weeks of pregnancy.

The research group working at Werribee in Australia under Dr. Paul Hemsworth have recently published some very useful data in relation to both gilt reproduction and for sows. One study has shown clearly the effects of stress in early life on reproduction much later in life. Piglets from 10 kg. liveweight were subjected to either a 'good handling regime', a 'poor handling regime' or minimal handling by people. In the poor handling group a definite protocol of electric shock treatment was applied. The results show emphatically that mis-handling in early life severely influenced the ability of the animals to develop normal puberty and conception. This is an extreme example but it elucidates the reality of man-animal interactions.

Practical conclusions

There are many lessons to be learnt from the recent scientific work carried out and there are now better recommendations for the design features of service accommodation and the management of mating. It is encouraging that many farmers use service areas to good advantage and put a lot of thought into the construction details. In the future we may see significant improvement in reproductive management with the gradual evolution of minimum stress systems leading to maximum financial

performance. For the moment the evidence points to taking great care with regard to the quality of stockmanship. Labour costs are considerably higher in the United States and Canada than they are in the UK. This tends to decrease the man/animal ratio to the detriment of the individual care of all animals. Despite the costs however it seems that the man or woman doing the day to day jobs on the farm can have the biggest impact of all on reproductive performance. Plenty of TLC (Tender Loving Care !!) should be the order of the day on the pig farm for best results. This general observation is substantiated by the performance of the best herd in a recent MLC survey in the UK. One farm achieved a litter size for a whole years production of 12.5 piglets born alive. On examination of this farm, the herd was about 120 sows and therefore not large and the stocking densities were modest. The farm was also weaning at 5 weeks of age which undoubtedly helped the situation. The principal reason for this high level of performance may have been because the farm was operated by the an owner/occupier. The farmer and his wife were the only stockpersons and therefore their whole living depended on their animals. Without really giving it much thought the farmer had evolved a stress-free system by principles of common sense.

In further experiments the Werribbee group have shown that stocking density in groups of cycling gilts can significantly affect the propensity of gilts to show a normal oestrus and be successfully mated at puberty.

The evidence we have to date on stress and pig reproduction points to a greater need for the careful consideration of the whole management programme with regard to stress to attempt to minimise the stressors imposed on individual animals. We should in the planning stages of new piggeries pay attention to stocking rates and group size and then adhere rigidly to the original plans. I would suspect that many farmers start with good intentions and as the economic pressures come to bear they squeeze in a few more animals with detrimental results. Some farmers in the UK have recently reverted back to less intensive systems and have found that in some cases with less animals in the same buildings they end up making more money. It is important also to identify with the animals themselves to try to imagine how the system we impose affects them. Too many compounded stressors at once is a recipe for depressed productivity. Moreover, the system of reproductive management it seems must begin when the animals are very young indeed and for those buying in gilt replacements from other farms this may pose some questions.

In conclusion, the evidence is now emerging that reproduction does respond remarkably to different stress levels. It is up to farmers, advisers and veterinarians to re-evaluate the systems to establish how much these relationships apply on different farms.

8.5 ARTIFICIAL INSEMINATION

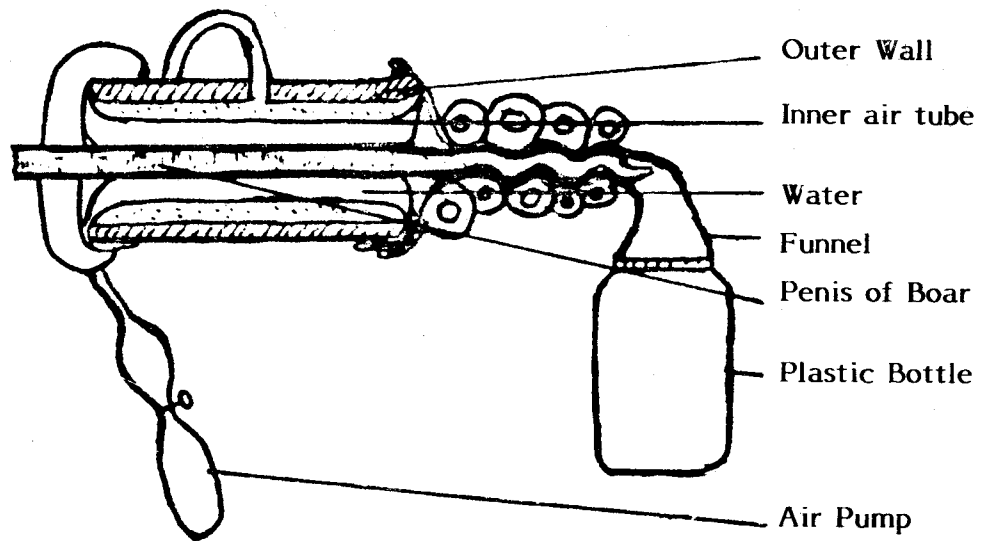
Chandra Shekher Sahukar, Ministry of Food Processing Industries,
NEW DELHI (INDIA)

The practice of artificial insemination on a commercial basis exists in some of the countries of the world - the Netherlands, Russia, Federal Republic of Germany, Denmark, United Kingdom, Japan, United States and China. Artificial insemination is the deposition of spermatozoa in the female genital tract by artificial instruments rather than natural service. It can offer better possibilities of health control ;reduction in the cost of breeding and management, to extend the usefulness of superior boars to - large number of sows. In countries with high density pig populations, artificial insemination cost is lower than that of natural service.

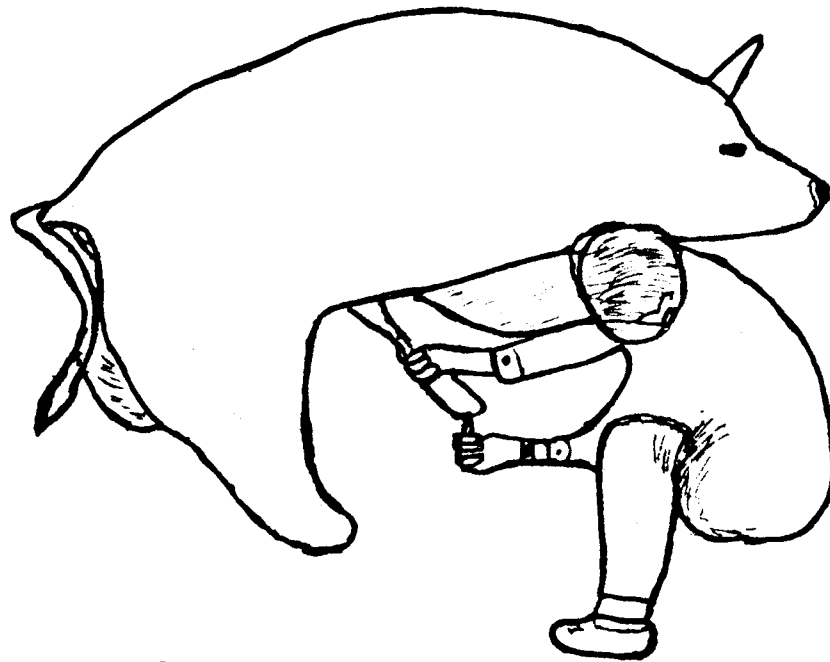
In our country this practice has been very slow to gain acceptance for several reasons such as, lower fertility and small litter size compared to that obtained in natural service; high cost involved in the expansion of artificial insemination practice. The advancement in the technique would offer possibilities of its use to satisfy the future needs of Indian pig industry. It will enable the maximum use of genetically superior boar for more sows. It will also provide a wider variety of new genes for herds at nucleus level for greater intensity of selection and to produce replacement breeding stock in commercial herds. The high cost of importing live pigs and problems of health certification have stimulated the increasing importance of artificial insemination with use of frozen semen.

Collection of Semen

Boar semen is easily collected in an artificial vagina. The most satisfactory method for collecting semen is by fixation of the penis by the hand method using a dummy sow as a teaser. A dummy sow, made of galvanized iron is fixed to light wooden platform so that the boar keeps it in place by means of his own weight. The artificial vagina and method of collection of semen is shown in Fig. 8.5.1. When the boar mounts the dummy the operator guides the penis into artificial vagina and tries to catch and hold the penis through the vagina with his right hand. The artificial vagina is fixed at proper temperature, 105 to 110°F, and pressure. As soon as penis is fixed in hand, the boar will begin to ejaculate and semen is collected in plastic bottle. Boar semen is ejaculated in fractions and from 10 to 15 minutes may be required for complete ejaculation. It is common practice to fractionate the ejaculate by allowing the accessory fluid and get to escape and collecting only the sperm rich fraction. This can be performed by filtering through a coarse gauge filter. The volume of ejaculate varies from 100-350 ml. The semen collection can be done once or twice a week without affecting the amount of spermatozoa.



Cross Section of Artificial Vagina for boar.



Method of Collection of Semen

Fig. 8.5.1 Artificial Vagina & Method of Collection.

Evaluation of semen quality

The volume of the boar ejaculate varies from 100-500 ml. depending upon the age and method of collection. The sperm density can range from 100 to 1500 x 10⁶ sperms per ml. The total sperms concentration per ejaculate may be 50,000 to 80,000 million.

The evaluation for quality is done by direct microscopic examination at 30-55° C on a warm stage. The sperm motility is assessed soon after its collection. Good samples will show a wave motion. The motion is more pronounced in the sperm rich fraction. In a poor samples there is a marked, clumping of the spermatozoa. The density is assessed by haemocytometer count. Evaluation is also based on semen volume, appearance, motility rating, sperm number, morphology count for abnormal form and proportion of live and dead spermatozoa.

Semen dilution

Diluted boar semen retains motility up to 4-8 days. The threshold number of spermatozoa required for normal fertility ranges from 2000-3000 million in a volume of 50 ml.

Boar semen is diluted 1:1 in Illinois variable Temperature (IVT) diluent and poured in 20-40 ml ampoules and sealed. Before use, dilute further with IVT up to 200 ml. The modified diluent has no egg yolk and is saturated with carbon dioxide. An average ejaculate can be diluted to perform 25-30 inseminations depending upon the time of diluent and method used.

The composition of two commonly used diluent is as follows:-

IVT (Modified)		Kiev (EDTA)	
Sodium citrate	20.0 g	D. Glucose	60.0 g
Solphanilamide	3.0 g	Trisodium citrate	3.7 g
Sodium bicarbonate	2.1 g	EDTA Disodium salt	3.7 g
Glucose	3.0 g	Sodium hydrogen carbonate	1.2 g
Potassium chloride	3.0 g	Distilled water	1.0 litre
Glass distilled water	1000 ml.	Streptomycin sulphate	500 ug/ml.
Penicillin	500 IU/ml.	Penicillin	500 IU/ml.
Dihydrostreptomycin	500 ug/ml.		

In both diluent semen can be stored up to 3 days at 16-18° C without loss of motility. But EDTA diluent gives a 5% higher conception rate than IVT.

Deep Freeze Storage

Deep freezing of boar semen would greatly facilitate international exchange of semen and long term storage of semen from valuable boars. Various techniques of deep freezing have been used by various scientists but they are not applicable in routine commercial practice because of low fertility compared with fresh semen. Farrowing rates with frozen semen will probably never be as high as those from liquid semen. However, an improved technique would make frozen semen more useful in the production of great grand parent stock and parent replacement stock. The conception rates and litter size with frozen thawed semen can be improved in future by development of techniques of freezing and thawing.

Time of Insemination

Time of insemination is the principal factor governing fertility and litter size. The ovulation occurs between 36-50 hour after the onset of heat but the best results can be obtained by performing insemination near the middle of heat. Sows should be inseminated 12 to 24 hours after the onset of standing for the boar or owner testing.

Synchronization of oestrus in gilts and sows

Synchronization of oestrus in gilts and sows would help in practicing batch farrowing to ensure maximum throughput in feeding and management. Synchronization of oestrous can be achieved by feeding of gonadotrophin - Suppressing compound, methallibure, at a level of 100 mg daily for 20 days. At 21st day 750-1000 IU of Pregnant Mare's Serum Gonadotrophin (PMSG) is injected followed by 500 IU Human Chorionic Gonadotrophin (HCG) at day 26. The animals will ovulate and insemination is done at day 26 irrespective of signs of oestrous.

Insemination Technique

The equipment for insemination consists of a catheter, which is a long rubber tube similar to the boar's penis, a thin walled plastic bottle which holds the semen and is attached to the catheter. The catheter is first lubricated with liquid paraffin and then inserted carefully and firmly upward into the vagina. Then the catheter is twisted gently, anticlockwise, until it locks in the cervix. After fixing in correct position, the plastic bottle is attached and squeezed very gently to allow the semen to flow. The insemination will complete in about 10-15 minutes (Fig. 8.5.2).

Longitudinal Section through the genital organs of the sow with the insemination tube in the cervical canal.

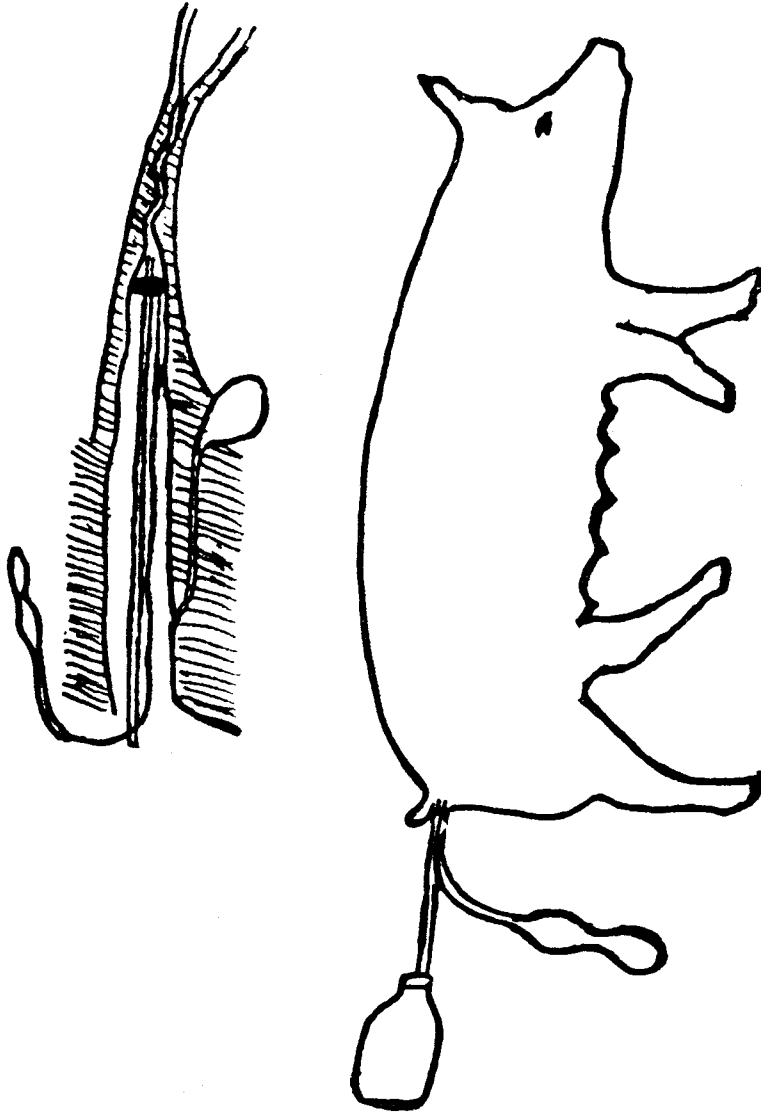
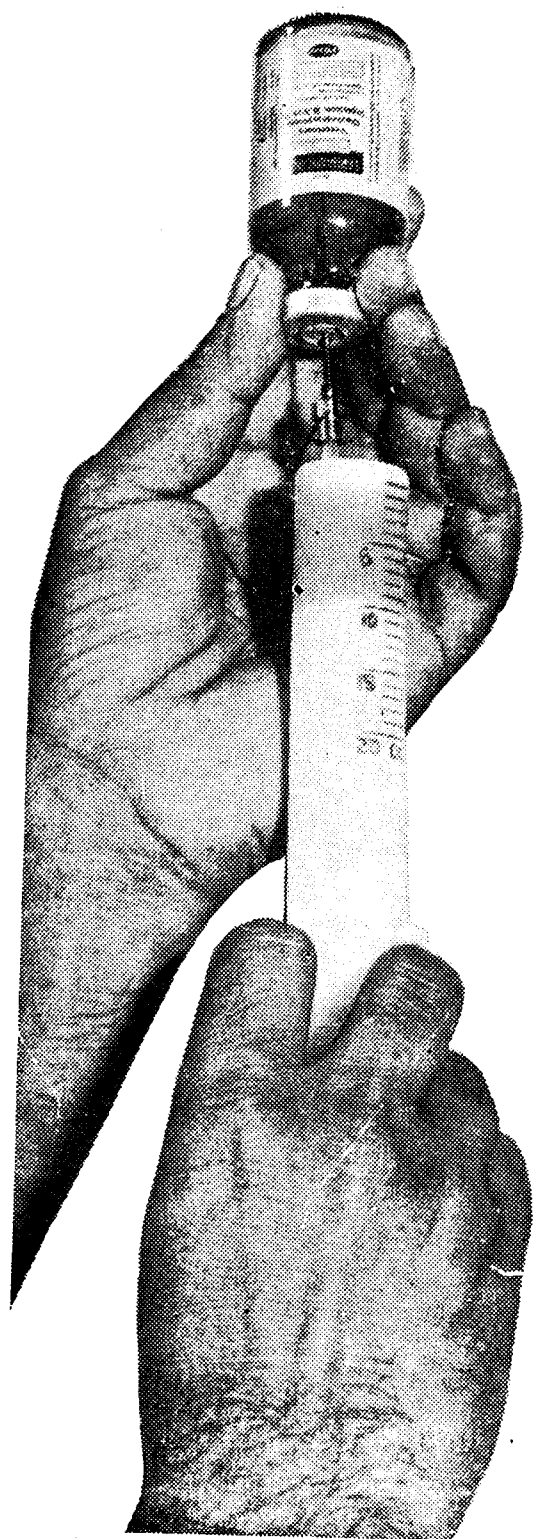


Fig. 8.5.2 Insemination Technique.

The high cost of insemination, lowered conception rate and litter size have not favoured the use of artificial insemination in our country. This practice would become more attractive if disposable insemination equipment would become inexpensive and readily available. Improvements in semen storage techniques would offer a efficient artificial insemination service for the benefit of pig farmers.



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CHAPTER IX

HEALTH AND DISEASE

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9.1 Health care and Control for Pig welfare

Disease is an important cause of unprofitability in pig production. Pigs are susceptible to a number of diseases, which effect their appetite, growth, feed efficiency and their ability to reproduce and give milk. At efficient husbandry system should act as barrier to the introduction of diseases from outside and a systematic method for controlling the diseases within. This system should be designed by the Veterinary Surgeon. The Veterinary Surgeon is not only to treat the sick animals but to look after the farm management, general hygiene, prevention and vaccination etc. in the farm. The fresh stock should be purchased from a known clean source. Prior to mixing with the healthy stock, it should be quarantined for 3 weeks. Transport vehicles should be parked away from the pig accommodation. These types of precautions may limit the movement of infections.

9.2 Bacterial Diseases:

The disease conditions responsible for heavy losses in swine are pneumonia, enteritis and pneumoenteritis. These conditions may be associated with bacteria, virus, chlamydia, mycoplasma and parasites.

9.2.1 Pneumonia

It is not a disease but clinical manifestation of the disease. It is more commonly found in young piglets particularly during the first four months of life. Possible sequence of infection in upper respiratory tract may be complex. It may be caused by bacteria, chlamydia, mycoplasma or viruses alone or in combinations. The disease condition is sudden in onset and usually whole litters are affected. There is rise of body temperature (104-107°F) and cessation of suckling. Other clinical manifestations may be coughing, respiratory distress and occasionally nervous disorders and lameness.

Treatment of bacterial pneumonia depends upon the causal factor such as Pasteurella, Salmonella or Mycoplasma. In case of pneumonia

caused by Pasteurella organisms, sulphadimidine 33.3% solution at the dose rate of 200 mg per kg body weight given intraperitoneally or subcutaneously gives good results. The treatment should be continued for 5-6 days. Broad spectrum antibiotics such as oxytetracycline or chlortetracycline at the dose rate of 10 mg per kg body weight given I/v or I/m is also quite effective.

If the cause is Salmonella organisms, the best treatment would be using chloramphenicol at the dose rate of 10-20 mg per kg body weight given I/m or I/v. When Mycoplasma is suspected to be the cause of pneumonia, then Tylosin at the dose rate of 2-10 mg per kg body weight gives good results.

Supportive treatment includes cleanliness, proper ventilation and provision of oxygen. The affected animals should be housed in warm rooms. There should be provision for fresh water, light and nourishing food. Exposure to inclement weather should be avoided. Forced oral feeding may also be avoided.

If it is a herd problem, affected pigs should be isolated and anti-septic inhalations may be used.

9.2.2 Enteritis

It is also one of the clinical manifestations of the diseases caused by bacteria, parasites and/or viruses. The change of diet, chill and unhygienic conditions are some of the predisposing factors for this condition. It is characterized by diarrhoea, dehydration and death. This condition may be treated with appropriate antibiotics along with symptomatic treatment as under:

E. coli is the main cause of infection. In such cases Furazolidone at the dose rate of 5-10 mg per kg body weight gives good results. Sulphonamides such as sulphaguanidine and sulphathalamide or sulphonamides in combination with streptomycin are quite effective. Sulphonamides can be given at the dose rate of 200 mg per kg body weight and streptomycin at 5-10 mg per kg body weight for 4-5 days. Chloramphenicol and tetracycline can also be used. If the cause of enteritis is due to Salmonella organisms, then chloramphenicol is the drug of choice. Iron deficiency should be corrected by giving injections of iron. Dehydration should be corrected by giving fluid therapy.

Control:

1. Food consumption should be reduced.
2. Antibacterial drugs such as neomycin, tetracycline, streptomycin and nitrofurazone can be used in drinking water or feed.

9.2.3 Colibacillosis

The causal organisms for this condition are Escherichia coli. Piglets may become ill within 12 hours of birth and die of acute toxæmia or septicaemia within 48 hours and often without diarrhoea. Diarrhoea appears shortly after appearance of lethargy in piglets surviving the first two days. The hair coat becomes rough. The animals become dehydrated and emaciated. There is discolouration of perineal area and tail due to coating of the faeces. On necropsy, milk clots are seen in the stomach. This disease may be kept under control by adopting strict hygienic measures and sick animals may be treated with antibiotics along with supportive therapy as mentioned earlier.

9.2.4 Salmonellosis

It is one of the important bacterial diseases caused by Salmonella species. The important salmonellae involved are Salmonella typhimurium and Salmonella choleraesuis. Mortality in clinically affected pigs is very high though morbidity is low. It is more common in young piglets than the adult ones. In acute form, it is characterized by dullness, depression, rise of body temperature, prostration and death. Diarrhoea, dysentery, meningitis and encephalitis have also been seen. On postmortem examination, the disease is characterized by catarrhal gastroenteritis.

Treatment:

Streptomycin or streptomycin in combination with neomycin at the dose rate of 10 mg per kg body weight given orally are very effective, Furazolidone in 5-10 mg per kg body weight given orally gives satisfactory results. The treatment may be repeated for 3-5 days. Bifuran containing 25% nitrofurazone and 3.6% furazolidone is valuable in Salmonella infection. It can be mixed in feed in recommended doses for 5-7 days for all pigs. Neomycin and chloramphenicol at 10-20 mg per kg body weight have been used as drug of choice. These compounds can be added in feed if the animal is still eating otherwise it may be given in drinking water. Sulphonamides such as sulphaguanidine and sulphathalamide have been widely used. Sulphamezathine both by mouth and by injection had been found to be very effective in controlling the outbreaks due to salmonellosis.

Control:

1. Proper attention towards sanitation.
2. Strict quarantine measures for newly purchased pigs for at least 3 weeks.
3. Advanced cases of diseases may be slaughtered.

4. Vaccination has also been attempted.
5. Provide clean, warm dry housing and also provide balanced ration containing nicotinic acid. Place pigs on concrete floors which are disinfected daily.

9.2.5 Pasteurellosis

The causal organism is Pasteurella multocida. The affected pigs show the clinical signs of bronchopneumonia. Initially coughing and dyspnoea are noted. In severe cases, there is rise of body temperature (105-106°F), nasal discharge, anorexia, depression, weakness, prostration and death within 5-10 days. The affected pigs may successfully be treated with antibiotics notably penicillin, streptomycin or tetracycline as well as sulpha drugs like sulfamethazine, sulfamerazine or sulfathiazole in recommended doses.

9.2.6 Tuberculosis

Tuberculosis in pigs may be caused due to Mycobacterium tuberculosis, M. bovis and M. avium. It is mainly acquired by feeding of garbage and human excreta. In generalized form, it is characterized by rise in body temperature, anorexia, loss of weight, dysphagia, dyspnoea and coughing. Granulomatous lesions may be present in any part of the body such as lymph glands, liver, lungs, spleen, joints and other organs. Treatment is not practical and disease may be contained by regular testing and segregation method.

9.2.7 Brucellosis

The disease is caused primarily by Brucella suis. It is characterized by abortions, stillbirths, infertility, unilateral or bilateral orchitis, posterior paralysis and lameness. Decreased sexual desire is occasionally observed in the affected boars. There is no effective treatment, however, the disease may be kept under control by regular testing and segregation of the affected pigs.

9.3 Viral Diseases:

9.3.1 Swine fever

It is a highly infectious septicaemia caused by a virus and characterized by the generalized haemorrhages, 95-100% morbidity and almost as high mortality. This infection usually runs an acute course but may become chronic. Lesions may be very mild or absent in peracute cases but severe to extreme in acute and subacute infections. Complications may arise due to the secondary bacterial infections, particularly with Salmonella cholerae suis or Pasteurella multocida.

The chief clinical signs noted in the affected pigs are dullness, inappetance, high rise of temperature, constipation, convulsion, staggering gait, conjunctivitis and bleeding from nose and rectum. Red or purplish blotches on the skin of the ears, belly and inner surface of legs may be present. Diarrhoea and pneumonia may also be present. There is no effective treatment for this infection. However, the disease may be kept under control by adopting hygienic measures and vaccinating the stock with swine fever lapinized vaccine (Attenuated).

9.3.2 Swine influenza

It is an acute infectious respiratory disease of swine caused by a type A influenza virus. It is sudden in onset and is characterized by conjunctivitis, lachrymation, coughing, dyspnoea, fever (105-108°F), prostration and rapid recovery. Morbidity is high but mortality is low. Lesions develop rapidly in the respiratory system and regress quickly except in a few complicated cases when a severe bronchopneumonia may be followed by death. Secondary bacterial invaders may complicate the disease condition and these organisms include Salmonella typhimurium, Pasteurella multocida and B. haemolytic E. coli. The affected animals may be given symptomatic treatment along with antibiotic to check secondary bacterial infections.

9.3.3 Swine Pox

It is a highly contagious disease caused by two antigenically distinct pox viruses i.e. Vaccinia virus and Swine Pox virus. The disease caused by these two viruses is indistinguishable under natural conditions. The pox is found to be transmitted through ticks, Hyalomma anatolicum and usually pigs between 2-4 months of age contract the disease. The affected pigs show restlessness, anorexia and slight rise of body temperature. Characteristic pock lesions are seen on the surface of the ears, face, neck, inner side of the legs and on the belly. At times ulcers in the digestive tract and pneumonia may be seen. Herd morbidity rate is high but mortality rate is almost negligible. The affected pigs may be given symptomatic treatment along with antibiotics for secondary bacterial infections.

9.3.4 Foot and Mouth Disease

It is highly contagious disease caused by Picorna viruses. The affected animals have an elevated temperature and are reluctant to stand and walk. The clinical signs include vesicles and erosions on the snout, lips and tongue, on the coronary band and between the claws on the feet. Morbidity is high but mortality is low except in young animals. In piglets, mortality is due to the involvement of heart muscles causing myocarditis. The disease may be kept under control by adopting strict hygienic measures and treatment of the foot lesions with 1% copper

sulphate or phenyl lotion and mouth with 2% alum or potassium permanganate lotion.

9.4 Parasitic Diseases

9.4.1 Internal Parasites:

I. Round worm infection:

- i) Ascaris suum: This species is cosmopolitan in distribution, occurring in the pigs. For many years this species was considered synonymous with the human parasite A. lumbricoides, however, there is now an evidence that these are distinct species.

A. suum is a large worm and a serious pathogen in swine. The adults live in the lumen of the small intestine, where they compete with their host for food and markedly decrease feed efficiency. The affected pigs become stunted, unthrifty and weak. They loose flesh and have a rough coat. Sometimes diarrhoea may develop. However, the effects of the larvae are even greater than those of the adults. The larvae migrate through the liver parenchyma and cause white spots and fibrosis. In the lungs, they cause verminous pneumonia, with an asthmatic cough - "thumps", difficult breathing, oedema, haemorrhagic foci and emphysema. Affected animals may die. Ascarids also exacerbate virus pneumonia.

Newly born pigs which become heavily infected, may show signs of pneumonia, especially a cough and exudate into the lungs. Larvae may be found in the sputum. Ascaris eggs are found in the faeces of older pigs or in the soil on which the animals are kept.

Treatment: Sodium flouride removes 90 per cent of mature and immature ascarids and it has been widely used. It must not be given with a wet feed because it may then be toxic; nor should it be given with whole grain. It mixes well only with ground grain, wheat meal or oat meal. It is not very palatable and is best given in the morning after starvation for 24 hours. It should not be given to pigs in poor condition. It can be given to pregnant sows. Satisfactory results are obtained when sodium fluoride is mixed with dry feed at the rate of 0.1 - 0.15 g per

lb body weight. Another method is to mix sodium fluoride as 1 per cent of the whole day's feed and to give this day's feed in three parts, in the morning, at mid-day and in the evening. This dose may be repeated, if necessary, after 4 weeks to remove parasites which have matured since the first treatment.

Piperazine compounds: These are usually administered in the food, 100-300 or 400 mg per kg body weight giving excellent results.

Thiabendazole: A mixture of 0.1 - 0.4 per cent in the feed has been reported to eliminate adult worms and also to have an effect on migrating larvae.

Prophylaxis: The eggs survive best in damp, dirty and overcrowded quarters so that cleanliness and good management are important. The animals should be removed to a temporary enclosure for treatment and transferred to fresh ground within 10 days, before any eggs passed by them become infective. Sites with concrete floors can be kept clean by scrubbing out with boiling water and soda every 10 days or longer, depending on the temperature.

The McLean County system of swine sanitation: It not only prevents Ascarid infections but many infectious diseases as well. It comprises four measures:

- (a) Cleaning the farrowing quarters before putting the sows in them. Scrub pen with a hand broom and plenty of boiling lye water containing 1 lb of lye per 20 gallons of water. Finally clean the quarters with high pressure steam or boiling lye water. Give final rinse with clear, hot water. Wash sows with a scrub brush, before putting them in the farrowing pens. This removes eggs that may be adhering to their bodies.
- (b) Haul the pigs and sows to pasture when the time comes. Do not drive them down contaminated lawns.
- (c) Keep the pigs on clean pastures which have not been used by pigs for several years.

- (d) Do not track worm eggs into farrowing pens on dirty shoes.

- ii) Metastrongylus: They live in the bronchi and bronchioles of swine. Three species are commonly found, M. apri, M. pudendotectus and M. salmi. They look much alike and mixed infections are the rule. Their life cycle is indirect. Infective larvae develop in earthworms. Lungworms are the causal agent of verminous bronchopneumonia in pigs. This infection is characterized by respiratory discomfort, cough and nasal discharge.

Treatment and control: Levamisole 8 mg/kg given in the water or levamisole resinate, given as 0.08% levamisole hydrochloride equivalent, in the feed has high efficiency in pigs and has broad spectrum activity against other parasites of the pigs. Mebendazole when given at 15 mg/kg body weight on two successive days shows activity but when given in pelleted feed no effect is noted.

Control measures include avoidance of the intermediate hosts. Little can be done to control earthworm populations, and pigs which run in dirty yards or at pasture, should be moved at short intervals to prevent ingestion of infested worms. Pastures which are known to be contaminated should be left for at least 6 months before restocking, although infected earthworms may persist in hog lots up to 4 years.

- iii) Trichinella spiralis: By far the most important parasite associated with pig muscles is Trichinella spiralis. Trichinella spiralis is unusual in that the same individual animal is both its definitive and intermediate host. The adults are found in the small intestine and the encysted larvae in the muscles. Most human infections come from eating uncooked or insufficiently cooked pork. Pigs acquire their infections mostly by eating uncooked garbage, other pigs or rats. The latter generally become infected from pigs. The parasite is of principal importance in human medicine and it is unusual for any obvious clinical entity to be associated with the infection in domestic animals. The diagnosis of T. spiralis infection in animals depends mainly on the detection of the infection at meat inspection.

Treatment: Thiabendazole has been demonstrated

to be effective against both the adult intestinal phase and the larval muscle phase. It has also been used successfully in human infection.

II. Flatworm infection

Fasciola hepatica (liver flukes) may be found in the bile ducts of pigs in endemic areas. The fluke is cosmopolitan in distribution and is the cause of fascioliasis or liver fluke disease (liver rot). Fasciola gigantica replaces F. hepatica in the tropics and subtropics, such as Africa, southern Asia, the southern United States and Hawaii. Its principal intermediate host is Lymnaea auricularia, which prefers a warmer climate than L. truncatula and is also a more aquatic snail.

Liver fluke infestation is common among pigs having access to areas of low lying pastures and stagnant water containing fresh water snails. This infection produces anaemia, emaciation and digestive disturbances in pigs. In swine treatment for this infection is subcutaneous injection of carbon tetrachloride mixed with liquid paraffin.

9.4.2 External Parasites:

i) Sarcoptic mange:

It is a chronic skin condition caused by Sarcoptes scabie var suis. It is characterized by itching and rubbing leading to thickened and wrinkled skin. There is loss of hair and abrasions on the skin. Skin papules may be seen on the rump, flank and abdomen.

Treatment: It includes insecticidal treatment in the forms of spray, dip and dust containing active principles of insecticides to treat external parasites.

ii) Lice:

Pig lice, Haematopinus suis effect the pigs. The affected pigs show restlessness, itching and rubbing. The heavy infestation may result to anaemia and consistent irritation interferes with growth rate and food conversion. Lice are destroyed by the treatments used for sarcoptic mites.

iii) Fleas:

These are not host specific and this infestation disturbs the pigs seriously. Besides, it can also transmit infectious diseases such as swine pox.

iv) **Demodex:**

Demodex phylloides causes caseous nodules in hair follicles and sebaceous glands. Secondary staphylococcal infection may occur. The mite is irritating but it apparently does little damage except to the leather.

The guidelines for insecticidal treatment of external parasites have been mentioned in Table 9.4.1.

Table 9.4.1 : Guidelines for Insecticidal Treatment of External Parasites

Active chemical	Concentration	Parasites affected	Direction for use	Slaughter with-holding time
Malathion	0.5 % emulsion	Lice, ticks,	Spray	Nil
	5% dust	fleas, lice	Dust thoroughly	
	2.5% emulsion	House flies and fleas	Spray houses and premises	--
Rotenone	1% powder	Fleas	Dust heads, becks & backs	Nil
Toxaphene	0.5% emulsion	Lice, mites	Spray thoroughly	28 days
Trichlophon (Neguvon)	0.125% emulsion	Lice, mites	Spray thoroughly	Nil
Lindane	0.06% emulsion	Lice, mites	Dip or spray	60 days (dip)
	1% dust	Fleas	Dust head, necks and backs	30 days (spray)
Ciodnin	0.25%	Lice	Sprays, pigs, pens and surrounding Repeat 7-10 days	Nil
Diazinan	0.05% emulsion	Lice, mites	Spray pigs 3 times at 10 days interval	14 days

9.5 Nutritional Deficiency Diseases

Pigs are also affected by nutritional deficiency and show scour

stunted growth and poor feed conversion efficiency. The important deficiency diseases in pigs have been mentioned as under:

9.5.1 Protein Deficiency

A very few feed ingredients provide the essential aminoacids required by the pigs. Therefore, diet should be formulated in such a way that it meets the amino acid requirements. Clinical signs of protein/amino-acid deficiency include poor growth, rough hair coat and impaired lactation. Lysine is very important for pig growth. The synthetic lysine supplement can be used for supplementing the diet.

9.5.2 Vitamins Deficiency

Vitamins are required in multiple amounts but its deficiency can be overcome by addition of vitamin supplements in the diet of pigs. Deficiency of vitamin-A during gestation results in multiple birth defects. Vitamin-D deficiency results in impaired calcium absorption which causes rickets in growing pigs. Riboflavin deficiency causes dermatitis.

9.5.3 Minerals Deficiency

All minerals should be balanced and supplemented in the diets. Salt is toxic to swine which is characterized by depressed growth seizures and paralysis. Phosphorus deficiency causes significant reduction in daily gain.

Iron deficiency causes Piglet anaemia in suckling pigs. Supplemental iron can be administered by swabbing the sow's udders with iron sulphate or by oral supplementation. After weaning iron should be provided in diet.

Iodine deficiency is also prevalent in new born piglets. The piglets are hairless having thickened skin. These are weak and die shortly after birth. Potassium iodide in suitable amounts may be added to the normal diet of the sows.

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Piperazine Hexahydrate

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☑ Ridema*

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☑ Pronil* H, Trypnil*

Coccidiostats

☑ Amprolium soluble powder,
Solution and premix
Amdon*, Mericlop*, Meridot*

Growth Promoters

☑ Replamin*, Meriplex*
Merivite* 100, AD₃, AB₂D₃,
and AB₂D₃K, Merinitro*
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CHAPTER X

FINANCING AND INSURANCE

10.1 Technical considerations for Financing Piggery Development Schemes

Dr. B.S. Sathe, General Manager, Technical Services Department, National Bank for Agriculture & Rural Development, Bombay (INDIA)*.

Pig is one of the most efficient feed converter amongst the domesticated livestock. It produces large number of piglets at a very fast rate and has advantage of short generation interval and high feed conversion efficiency. Pig rearing is an important activity under mixed farming and is an important supplementary source of income to large number of small and marginal farmers especially in the North Eastern and Eastern sector of India. Pig rearing is largely confined with very poor farmers, tribals and people belonging to scheduled castes and scheduled tribes. Therefore piggery schemes can be an important subsidiary activity for above class of people. The present population of pigs of about 6.5 million largely consists of non-descript poor quality animals with low feed conversion efficiency and growth rates. However, efforts have been made by Government of India to improve the poor production capacity of these animals by cross breeding local pigs with some of the well known foreign (exotic) breeds such as Large White Yorkshire, Middle White Yorkshire, Land Race, New Hampshire breeds etc. Most of the State Governments have breeding farms with exotic pigs from where male breeding animals can be supplied to small farmers for cross breeding of their female breeding stocks. Pig farming is more popular in the North Eastern States because of the following facts.

1. Pig is a very popular animal kept as a backyard unit by most of the farmers.
2. The pork i.e. pig meat is in great demand and is a regular part of the diet of most of the tribal people in North Eastern sector.
3. Local and cheap home - grown feeds are available with most of the farmers.

In order to create processing infrastructure facilities, Govt. of India, with the assistance of FAO, had established 8 bacon factories in Andhra Pradesh, Uttar Pradesh, Rajasthan, Kerala, Maharashtra, West Bengal, Bihar and Punjab with the output capacities of 50 to 100 pigs processed per day. However they are mostly established in the plains,

* The views expressed by the author are not necessarily of the Bank he represents.

where the demand for pork is less. Therefore, most of the State Governments are planning to modernise these factories with a view to diversify them for processing of other meats from goats, sheep, poultry, etc.

NABARD refinance is available for following 2 types of piggery schemes - (1) Scheme for pig breeder, where adult pigs are financed. The farmer produces piglets and sells them to other farmers, as weaner piglets, (2) The small farmers purchase the weaner piglets from the pig breeders. These piglets are then reared for 4 to 6 months and after fattening they are sold in the market as fattened pigs for pork production.

Object of finance

The object of finance may be following:-

- i) Establishment of a farm for production of weaner piglets/breeders to be sold to farmers. This may include housing, water and electric facility, road, fencing, equipment including weighing scale and ramp for loading of pigs, transport facilities, pork processing and marketing facilities, feed mill etc.
- (ii) Financing small farmers for purchase of pigs, housing, equipment and supplementary concentrate feed.

Technical feasibility

Conduct on-the-spot study. Obtain and report following information:-

a) Potentiality of area for proposed development

Consult the officers of State Animal Husbandry Department, SFDA/MFAL projects. Ascertain if pig production in the area has been generally successful. The areas recommended by the State Government for intensive pig development programmes should be preferred. Certain districts have been specially recommended by the National Commission on Agriculture for pig development programmes. Selected villages should be in a compact block and easily approachable by road.

b) Suitability of climate

The climate should be suitable for maintaining pigs in optimum health and production. Obtain information on rainfall, environmental temperature, proper drainage of land, soil condition, etc. Avoid water logging conditions.

c) **Availability of agricultural by-products & waste products**

Proximity of land for foraging purposes and availability of agricultural by-products, waste materials and home grown feeds such as tapioca, rice bran, broken rice, tubers such as sweet potato, potato, raw forest fruits such as banana, arrum, mustard and other leafy vegetables, molasses, distillery waste, pulse-chunies, wheat bran are commonly used for feeding of pigs in rural areas, depending upon their availability. Ascertain the availability and costs and the quantity used to arrive at expenditure on such feeds.

d) **Availability of water**

Adequacy of fresh, clean and soft water for drinking purposes for pigs should be assured.

e) **Availability of concentrate feed**

Although feeding of concentrate to pigs is not common in India, it is necessary to give supplementary concentrate to highly producing improved indigenous, exotic or crossbred pigs. The amount of concentrate required would depend upon the foraging conditions and the quality and quantity of agricultural by-product feeds commonly fed to pigs. Concentrate may be required for the breeding males and females and for piglets after they are weaned from mothers at the age of 2-3 months.

The agency to supply the concentrate feed and the cost should be ascertained.

f) **Type of animal**

Consult the officials of the State Animal Husbandry Department for existing breeds of pigs available in the area and the breeding policy recommended by the State Government. 3 types of pigs could be financed:

- i) Exotic breeds of white or black coloured pigs, depending upon particular preference for colour in the selected area.
- ii) Cross bred pigs produced at the breeding farm.
- iii) Selected improved females of indigenous breed of pigs and pure bred exotic or cross bred male pigs.

In case of area development scheme for farmers, it would be desirable to adopt a breeding policy in which cross bred pigs with 50 per cent exotic blood (inheritance) could be produced. Proper ratio of males to females should be assured for optimum breeding efficiency.

g) Availability of animals and cost

Depending on the breed selected, its availability in the State Government farms, private farms, etc. should be ascertained. The herd-size per farmer may vary depending upon the type of scheme and the capacity of the farmer to make available home grown feeds for pigs. Selected and progressive farmers who have sufficient land to produce home grown feeds, may be given a breeding unit of 3 sows (females). One breeding male may be supplied to a group of 5 such farmers. The farmers who have very limited capacity to produce home grown feeds may be given 3-5 weaner piglets of 2-3 months of age to raise them for 6-9 months for fattening purposes. Ensure that purchase committee includes veterinary officer and a certificate indicating the age and health of the animal should be available after they are purchased. The names of government pig breeding farms, the breeds of pigs and their cost should be indicated.

h) Housing and equipment

The need for housing and equipment and their costs should be estimated. Adult breeding pigs and weaner fattening pigs should be kept separately.

i) Production performance of the suggested breed of pigs

Assess the production criteria such as litter size at birth (number of piglets born during farrowing), litter size at the time of weaning, interval between two farrowings, percentage mortality in adults and body weight of weaner-fattener pigs at the marketing time. Study the above criteria as obtained in the local area.

j) Requirement of labour, medicine and contingencies

Assess the need and the cost involved.

k) Income by sale of weaner piglets and fatteing pigs

Assess the quantity available and the current market prices for above items.

l) Marketing facilities

The markets where weaners and fatteners can be sold should be indicated. The facilities available for collection transport, slaughter, processing and marketing of pork and the market price should be indicated. Whether facilities are available for ante-mortem and post-mortem examination of slaughtered animal for declaring pork as fit for human consumption should be indicated. The transport, marketing and processing cost on the produce, if any, should be ascertained. The names of nearby slaughter houses where pigs can be slaughtered should be indicated. Whether pig producer's co-operative societies exist in the area should be indicated.

m) Veterinary aid

Consult the staff of local state veterinary department. Give the location of veterinary hospitals in the scheme area. Facilities in terms of qualified staff, laboratory, treatment and vaccination of animals should be given. In case of certain parasitic diseases of pigs, precautions to be taken for periodical deworming should be indicated.

n) Facilities for breeding of pigs

Adequate facilities for production and supply of breeding males required for the programme should be assured.

o) Knowledge of the entrepreneur in pig farming

Ascertain if the entrepreneur has adequate knowledge with regard to pig farming including housing, feeding, breeding, sanitation and disease prevention. Whether there are pig producers' co-operative societies in the area should be indicated. Whether the farmers have experience of scientific slaughtering should also be indicated. If not, the arrangements to be made for training of farmers and the agency to provide the training should be indicated.

p) Training of technical personnel

Ascertain need for training of technical personnel and the agency to import such training should be indicated.

q) Organisation for Project Execution and Follow up

Indicate the agency to execute and follow up of the project. This may include staff of DRDA, State Department of

Animal Husbandry, Veterinary Department, pig breeders co-operative societies etc. Co-ordination of various agencies should be ensured.

10.2 Economics of Commercial Swine Production

Dr. B.D. Sharma, Associate Professor, Department of Animal Breeding & Genetics Ranchi Veterinary College, Ranchi-834007, (INDIA).

The real challenge before us is to make pig production an economically viable enterprise so that it could attract breeder in a large way. This goal can only be achieved by using low input technology. We shall have to achieve success in increasing the body weight and carcass quality of the pigs by using economic feed based on agricultural wastes and unconventional by-product. For the improvement of piggery development works Department of Animal Husbandry and Agricultural Universities are imparting all types of facilities to the pig breeders under different types of development schemes so it is urgently needed to work out the approximate expenditure and return on pig farming.

The main objective of this paper is to give the financial working of a small commercial pig farm. The care has been taken to construct the house with a low cost materials, the wall will be constructed with bricks and mud pointed with cement (3:1 ratio), roof with tiles and floor with 3" concrete cement. The cost of land has not been included in the expenditure, because it is expected that the farmers who are traditional pig breeder must have at least minimum of half an acre of land for this purpose. An unit of 10 sows with followers are supposed to be considered as the minimum economic unit. For this the farmer or his employed labour must give on an average 3-4 hours per day. It will be better if the pig farming be associated with mix farming especially fish farming. Here a project on establishment of cheap piggery farm having a capacity of 25 sows with followers has been worked out.

Financial working of a small commercial pig farm with 25 sows and followers for 18 months

Capacity - 25 sows and 3 boars.

Fixed Capital

Land: for the construction of pig house with store and office room. 1/2 acre of land is needed.

Construction of pens:

- (a) Three pens for three boars (10' x 8') with run of 450 sq.ft. (10' x 7') space.

(b)	Ten farrowing pens (10' x 8') with run (10' x 7')	1500 sq.ft.
(c)	Five dry sow pens (10' x 8') with run (10' x 7')	750 sq.ft.
(d)	Five weaners pens (20' x 8')	800 sq.ft.
(e)	One office cum store room (25' x 15')	375 sq.ft.

Total: 3875 sq.ft.

Cost of construction Rs.40.00 per sq. ft.

$$3875 \times 40 = \text{Rs.}1,55,000/-$$

Purchase of foundation stock

The piglets of about 30 kg weight will be purchased from Govt. farm which will be ready for breeding when they attain a body weight of about 70 kg. This gain of weight of 40 kg will be attained in 4 months after purchase. The feed required during these periods will be @ 1 kg per day per head. The piglets should be allowed for grazing on an average for three hours daily. Each sow will give nine weaned piglets after farrowing. Thus the total weaners will be $25 \times 9 = 225$.

Expenditure:

1. Purchase of foundation stock:- 25 gilts and 3 boars of approximately 30 kg @ Rs.15/kg $28 \times 15 \times 30 = \text{Rs.}12,600/-$.
2. Expenditure on feed:-
 - (a) Feed required by breeding stock when they attain the age of puberty (for 120 days) $28 \times 120 \times 1\text{kg} = 3360 \text{ kg}$.
 - (b) Feed required by 25 sows during pregnancy for 114 days @ 2 kg per day per head - $25 \times 114 \times 2 = 5700 \text{ kg}$.
 - (c) Feed required by 25 sows for 56 day after farrowing @ 2.5 kg per day per head $25 \times 56 \times 2.5 = 3500 \text{ kg}$.
 - (d) Feed required by 3 boars for 230 days @ 2 kg per day per head - $3 \times 230 \times 2 = 1380 \text{ kg}$.
 - (e) After one month of weaning all 25 sows are expected to be pregnant. Hence the feed required for 25 sows up to the day of farrowing i.e. for 144 (114 + 30) days @ 2 kg per day per head will be $25 \times 144 \times 2 \text{ kg} = 7200 \text{ kg}$.

(f) Feed required by 25 sows up to the date of weaning i.e. for 56 days @ 2.5 kg per day per head $25 \times 56 \times 2.5 = 3500$ kg.

(g) Feed required by 225 gilts for six months i.e. 180 days @ 1 kg per day per head $225 \times 180 \times 1 \text{ kg} = 40,500$ kg.

Total quantity of feed required 65,140 kg cost of 65,140 kg feed @ Rs.2.00 per kg = $65140 \times 2 = \text{Rs.}1,30,280$.

3. Labour charge of 3 labours for 18 months @ 15/- per day per labour $3 \times 15 \times 30 \times 18 = \text{Rs.} 24,300.00$.

4. Miscellaneous expenditure Rs. 10,000.00

Total expenditure:

1. Construction of pig house	Rs. 1,55,000.00
2. Purchase of foundation stock	Rs. 12,600.00
3. Feed cost	Rs. 1,30,280.00
4. Labour charge	Rs. 24,300.00
5. Miscellaneous	Rs. 10,000.00

Total Rs. 3,32,180.00

Income (Receipt)

1. Sale of 225 weaners of approximately 10 kg body weight @ Rs.15/- per kg $225 \times 10 \times 15 = 33,750.00$.

2. Sale of 220 young stock of approximately 70 kg body weight after six months of age @ Rs.15/- per kg $(220 \times 70 \times 15) = 2,31,000.00$.

3. Value of 28 breeding stock which have attained the body weight of at least 150 kg @ 10/- per kg
 $(28 \times 150 \times 10) = 42,000.00$

4. Sale receipt from manure = 6,000.00
 Total receipt = $(33,750.00 + 2,31,000.00 + 42,000.00 + 6,000.00)$
 $= 3,12,750.00$

Assessment of Profits

(a) Total receipt for $1\frac{1}{2}$ years Rs. 3,12,750.00

- (b) Total expenditure excluding cost of construction of pig house Rs. 1,77,180.00
- (c) Gross profit for $1\frac{1}{2}$ years (a-b) Total Rs. 1,35,570.00
- (d) Depreciation cost of building is 10% per year. So the depreciation cost of building for 1 year & 6 months is 15% on Rs.1,35,000.00 i.e. Rs.23,250.00
- (e) Bank interest (on an average of 10%) on Rs.3,32,180.00 = 33,000.00
 Net profit = (c-d-e) in $1\frac{1}{2}$ years Rs. (1,35,570 - 23,250 - 33,000) = 79,320.00

Note: Amount shown against the different items in the project report is subject to change of price from time to time.

10.3 Economics of Pig Rearing under Village conditions

R.L. Singh and S.K. Singh, Birsa Agricultural University, Ranchi Veterinary College, Ranchi - 834007, (INDIA).

With the adoption of improved technology on pig breeding (rearing of graded pigs for more profit) by the farmers of Chotanagpur and Santhal Parganas (Bihar) it is desirable to work out the economics of rearing graded pigs in comparison to native ones under village conditions. This information would be helpful in extending the technology rapidly.

Data on the desired parameters of pigs for the study were collected from six adopted villages of the Birsa Agricultural University, Ranchi under Lab to Land Programme and Adaptive Research on pig breeding, and have been analysed as under:

The study is based on the herd size of 5 pigs.

Input	Graded (Exotic male X desi female) pigs	Desi pigs
1. Cost of 5 weaned piglets @ Rs.15/kg live wt. (The average weaning wt. of graded piglets is approx. 8 kg; for desi about 4 kg)	Rs 600.00	Rs 300.00

Input		Graded (Exotic male X desi female) pigs	Desi pigs
2.	Cost of feed for 300 days (The piglets are kept on grazing for 2-3 hours daily)	Rs 450.00	Rs 350.00
3.	Repair of pig house including construction of feeding trough	Rs 200.00	Rs 200.00
4.	Miscellaneous including cost of medicines	Rs 50.00	Rs 50.00
		Rs 1300.00	Rs 900.00
Income			
1.	Total live weight of the piglets after 10 months of rearing (The average wt. for graded pigs - 50 kg; for desi 30 kg)	250.0 kg	150.0 kg
2.	Mortality of piglets upto one year of age @ 5%	(-) 12.5 kg	7.5 kg
	Total live wt. at the one year of age	237.5 kg	142.5 kg
3.	Amount of pig meat on slaughter at 12 months of age (dressing percentage-70%)	166.25 kg	99.75 kg
4.	Cost of meat @ Rs.20/- per kg	Rs 3325.00	Rs 1995.00
5.	Net profit	(Rs.3325 - Rs.1300) = Rs.2025/-	(Rs.1995 - Rs.900) =Rs.1095/-

The difference in Net Profit between graded and desi pigs -

$$\begin{aligned} & \text{Rs.2025} - \text{Rs.1095} \\ & = \text{Rs.930/-} \end{aligned}$$

10.4 Role of Commercial Banks in Piggery Development

Dr. Subhash Chandra Anand, Manager, PS & LB Division, Punjab National Bank Head Office, 5, Sansad Marg, New Delhi-110001, (INDIA).

Piggery can act as a subsidiary source of employment and income for small & marginal farmers and landless agricultural labourers. Medium and large farmers can also enhance their level of income by taking piggery as a supplementary enterprise. An entrepreneur may adopt piggery as his main activity, as the potential of profit offered by pig farming is very attractive. In view of the requirement of supporting all such employment generating programmes in general and raising farm production in particular banks are providing financial assistance for agricultural and allied activities viz. poultry, piggery etc. on priority basis. Public sector banks have been called upon to step up their direct financial assistance to such sector of economy to the extent of 18 percent of their total credit. Apart from 20 public sector banks and 29 State Co-operative Banks, 196 Regional Rural Banks are financing for such activities through the network of their branch offices. On the part of banks, piggery credit is envisaged with twin objective of generating employment and increasing the production of pork and pork products. Financial assistance is being provided by banks on the following terms and conditions:-

1. Purpose

(a) Breeding of Pigs

For purchase of exotic breed like Large or Middle White yorkshire (White breed), Land Race (Brown), Large Black, Saddle Black, Hampshi e (Black breed) etc. or cross bred pigs, construction of pig pens and purchase of equipments.

(b) Rearing of Pigs

For purchase of weaner piglets (1-2 months old) for rearing/ fattening upto a period of 9-12 months for disposal in the market.

(c) Establishing Commercial Farms and Pork Processing Units

Finance may also be considered for establishment of a farm on commercial lines as main activity for production of piglets/breeders. Under this, financial assistance may include housing, water and electricity facility, fencing, equipments including weighing scale, pork processing facilities etc.

(d) **Purchase of Working Capital Inputs**

Purchase of feed and medicines for a period not exceeding 9 months and other working capital inputs.

2. **Eligibility**

Farmers/agriculture labourers and any individual desirous of undertaking piggery as subsidiary activity. The persons who are desirous to undertake the activity on commercial lines as main activity should have adequate experience in breeding/rearing the pigs on scientific lines and adequate land area to keep the pigs. The area where the activity is prepared to be undertaken should preferably be the areas recommended by the State Government for intensive pig development or suitable for undertaking this activity.

3. **Extent of Loan**

(a) **Pig Breeding**

- **For Subsidiary Activity:** Need based and according to the unit cost approved by the Unit Cost Committee for that area. The loan components may include purchase of boar (male), sows (female pigs), construction of shed, purchase of equipment, feed for a period of 9-12 months, medicine and insurance cost as a composite loan.
- **For Main Activity:** Need based according to the project report submitted by the intending borrower which should be scrutinised for its techno-economic viability and cost of the items involved. In respect of loan for working capital inputs a separate cash credit limit may be granted as per requirements.

(b) **Pig Rearing**

Need based loan is to be given. Loan assistance is provided for purchase of weaner piglets, construction of pig-pens, purchase of feed upto a period of 9-12 months, medicine, equipment, insurance cover etc. on composite basis.

While considering the extent of loan for various items of development, the following guidelines may also be kept in mind in addition to the project report and unit size/cost:

- Progressive farmers who have sufficient land to produce homegrown feeds, may be financed a minimum breeding unit of 1 boar and 3 sows. Farmers who have very limited

capacity to produce home grown feeds may be preferred for undertaking rearing activity. The unit size/cost approved by State unit cost committee may be kept in mind while processing the loan requirement.

- Proximity of land for foraging purposes and availability of agricultural by-products, waste materials and home grown feeds such as tapioca, rice-bran, broken rice, sweet potato, potato, raw forest fruits such as banana, leafy vegetable, molasses distillery waste etc. may be ascertained to work out feed requirement.
- The quantity of supplementary concentrate feed will depend upon the foraging condition and the quality and quantity of agricultural by-products available in the area.

4. **Margin (Contribution by the borrower from own sources)**

- i) For loans upto Rs.5000/-
 - a) Small farmers, agri-labourers, and others who are covered under IRDP and other Govt. sponsored programmes and for whom subsidy is available. **Nil**
 - b) For borrowers mentioned above but to whom subsidy is not available. **5%**
- ii) For all term loans and borrowers not covered under (i) **15-25%**

NOTE

- ° It has recently been advised that banks should not ask for margin for loans upto Rs.10,000/-.
- ° Where subsidy is available the same should be treated as margin and no further margin money should be stipulated for such units.
- ° The labour, material etc. contributed by the borrower for implementation of the activity should be taken into account for building up margin.

5. **Security**

Where movable assets are created

- i) For loans upto Rs.5000/- Hypothecation of assets created out of bank loan.

- ii) For loans above Rs.5000/- (a) Hypothecation of assets created out of bank loan.
- (b) Mortgage of land/third party guarantee.

Where movable assets are not created

Rs.1000/- and above Mortgage of land.

NOTE

- ° In cases where legislation on the lines suggested by Talwar Committee has been passed, a simple declaration creating a charge on the land offered as security will be sufficient. In such cases mortgage of land may not be necessary.
- ° RBI has recently advised banks that they should not ask collateral security for loans upto Rs.10,000/-.

6. Mode of Disbursement

It should be ensured that the animals are of reputed breed and are purchased preferably from either Government breeding farms or private breeders of repute. The payment for the animals, feed etc. should be made directly to the suppliers on behalf of the borrowers. However, in cases where it is not practicable, cash may be released to the borrowers in stages.

7. Interest

Medium Term Loans (Repayable in 4-5 years period)

For Small Farmers - 10.00% & For Others - 12.50%

Short Term Loans (Repayable in 1 to 2 years) OR Cash Credit Limit for Working Capital

Rate of interest depending upon the quantum of such loan/limit shall be 10 to 15.5%.

8. Repayment period

Repayment of medium term loan is to be made in suitable instalment within a period of 4-5 years including grace/gestation period of upto to one year commensurate with the time of sale of weaner piglets and/or sale of reared adult pigs for meat purpose. Working capital loan will be repaid in a maximum period of $1\frac{1}{2}$ years.

9. Other Terms and Conditions

- (i) Pigs when financed for breeding should be preferably within the age group of $1\frac{1}{2}$ to 2 years, healthy and suitable for that area. The officials of State Animal Husbandry Department may be consulted on the breeds of pigs available in the area, usual size of piggery unit, the breeding policy recommended by the State Government etc. A certificate of age and health from the Veterinary Surgeon/Official of the State Animal Husbandry Department should be obtained.
- (ii) The animals may be got insured especially in case the financing has been done for the purpose of breeding-and-rearing of the pigs.
- (iii) Efforts should be made to link repayment of loan instalments with supply of the said products to some marketing agencies.
- (iv) Adequate veterinary facilities should be available in the surrounding areas.
- (v) Requisite space should be available for pigs.

10. Special facilities for small farmers belonging to weaker section of society

- (i) They are provided subsidy @ 25% of capital cost in the case of small farmers and @ 33% in the case of marginal farmers and landless agricultural labourers. In the case of tribal beneficiaries higher amount of the subsidy is provided @ 50% of the capital cost. The amount of subsidy, however, is restricted to Rs.3000 per family in non-DPAP (Drought Prone Area Programme) and Rs.4000 in DPAP areas. The amount of subsidy for tribal beneficiaries is however, upto Rs.5000/-. Subsidy is given as non-repayable grant to the beneficiary alongwith bank credit which is repaid by him in suitable instalments.
- (ii) Lower interest rate of 10% per annum is charged to them as compared to other beneficiaries who are charged interest @ 12.5% as said above.
- (iii) In the case of beneficiaries of Differential Rate of Interest (DRI) scheme interest @ 4% only is charged to them.
- (iv) Comparatively longer repayment period is allowed to them vis-a-vis other beneficiaries with an objective of allowing

retention of adequate incremental income with the beneficiary.

- (v) Upto a loan amount of Rs.10,000/- no collateral security or third party guarantee is required as per recent RBI guidelines.
- (vi) They are required to pay lower premium for insurance of their assets/livestock as compared to other beneficiaries. Premium @ 2.25% per annum is charged in the case of subsidy linked financing as against 4.5% per annum in other cases.

11. Procedure of lending

In case of financing under the ordinary lending scheme and the DRI scheme, the intending borrower has to approach the Branch Manager alongwith his loan proposal. If the Manager is satisfied with the loan proposal, the customer will be asked to fill up loan application form supported with following documents.

- (i) Loan proposal,
- (ii) No dues certificate from financing institutions operating in the area.

Under the subsidy linked programmes, an intending borrower has to file his application to bank through his Gram Pradhan and Block Development Officer (BDO) and District Rural Development Agency or any other sponsoring agency providing subsidy. After completion of the above formalities, the Branch Manager instructs the Field Officer/Agriculture Officer/Rural Development Officer to visit the site of the intending borrower. The Bank Officer during his visit, to verify the party's integrity, honesty and status and draws an eye sketch of the site. He also tries to appraise the technical feasibility and the expected incremental income from piggery to be financed. On the basis of all this, he makes his judgement on the party's credit worthiness. An inspection report is then prepared with recommendations regarding amount of loan, appraisal of technical, economic and financial feasibility. In case, the project is satisfactory and the loan proposal falls within his jurisdiction, the Branch Manager sanctions the loan. Otherwise, he sends the proposal alongwith his recommendations to the Bank's Regional, Zonal or Head Office for sanction as the case may be.

Following items of investment are taken into account for the purpose of working out the cost outlay of the project:-

Fixed costs

Cost of purchase of land or the total lease amount if the land is taken on lease.

- ° Cost of construction of farm structures e.g. pens, store, fencing, water/electricity arrangement etc.
- ° Cost of breeding/stock accounts to 80% of fixed cost.
- ° Cost of equipments.

Working Capital Cost

- ° Expenditure on feeding on suckling, creeping and growing stages.
- ° Amount for veterinary aid.
- ° Cost of insurance.
- ° Cost of repair/maintenance and farm labour.

The proposal is considered to be economically viable if the cash outflows from a piggery unit are sufficiently more than the cash inflows. It should leave worthwhile surplus with the beneficiary as an incentive for him to undertake the piggery activity.

To encourage bank loans for development of piggery units NABARD (National Bank for Agriculture and Rural Development) provides refinance to the banks to the extent of 70% of their loans. Beside the refinance support, the bank loans are covered by the Deposit Insurance & Credit Guarantee Corporation (DICGC) of the Government for the purpose of guaranteeing the repayment of loans in the case of loans becoming bad and doubtful of recovery. This cover is available upto 60% of the amount in default upto a specified amount.

10.5 Insurance Coverage

Dr. Ajay Kumar Verma, ADM, Oriental Insurance Company Limited, Divisional Office, 124, Napier Town, Jabalpur-482001, (INDIA).

Pig insurance is an important input for encouraging the farmers to invest in high quality crossbred animals for augmenting meat production. The General Insurance Corporation of India (GIC) and the four subsidiaries Companies have extended the insurance facility for pigs. A master policy has been introduced in consultation with banks for automatic coverage of all financed animals right from the period of purchase. In order to provide effective thrust for the development of pig insurance business, the insurance companies have spread their branches network.

Government agencies are trying to raise the living standard of persons falling below the poverty line. Various Government schemes

have been evolved to help farmers like Integrated Rural Development Programme (IRDP), Small Farmers Developing Agency (SFDA), Marginal Farmer and Agricultural Labourer (MFAL), Special Livestock Breeding Programme (SLBP) and Drought Prone Area Programme (DPAP) Projects. The pigs subsidised under these schemes given a special low cost insurance cover at a premium rate of 2.75 percent.

Insurance covers have been devised for all indigenous, crossbred and exotic animals. To have the continuity of insurance, a long term cover over 3 years with a premium discount of 25 percent has been devised. All pigs are insured from 6 months to 3 years of age. The valuation/sum insured varies depending upon the breed of the pigs. Maximum sum insured for indigenous pigs is Rs.500/-. For crossbred and exotic animals as certified by Veterinary Surgeon at the time of proposal which varies on the basis of their purpose either breeding or fattening. The rate of premium is 5% of the value of pigs but for pigs covered under Government Schemes, the rate is 2.75% per annum.

The insurance becomes of paramount importance in providing opportunity for money back guarantee to the bank in the event of death of pigs financed by them. It also opens new avenues for the farmers to receive fresh loans by which they can again purchase pigs and continue production.

CHAPTER XI

PORK PROCESSING INDUSTRIES

11.1 Modern Technology in Slaughtering of Pigs

11.1.1 Preslaughter handling

P.C. Panda, Department of Animal Products Technology, Haryana Agricultural University, Hissar, (INDIA).

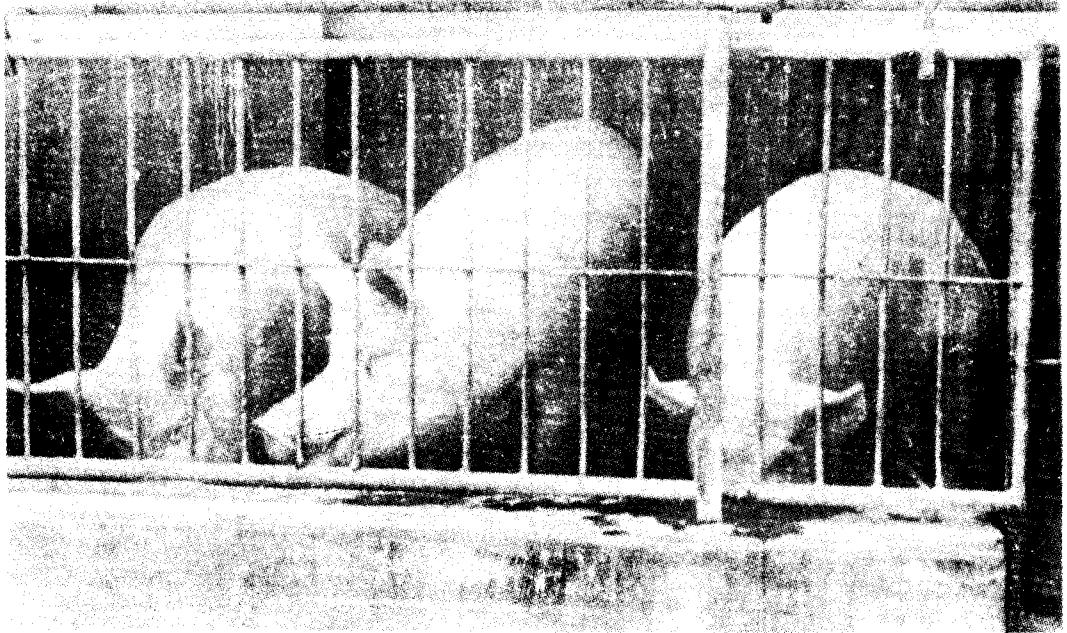
It is well established fact that pigs are more susceptible to transport stress, when compared to other type of meat animals. The factors for the weight loss may be many such as initial body condition of the animal, crowding, overloading, season, duration of journey, mode of handling and transport. It has been shown that bacon pigs lose carcass weight of about 0.9 kg for every day of their journey. In general, pigs lose 2.2 to 5.4 kg of their live weight during 24 hours of journey. Mortality and loss of weight during transportation can be reduced to minimum by adapting following measures.

- i) Never feed the pigs heavily before commencing the transportation.
- ii) Provide adequate ventilation and avoid suffocation.
- iii) In summer, restrict transportation to early morning hours of the day.

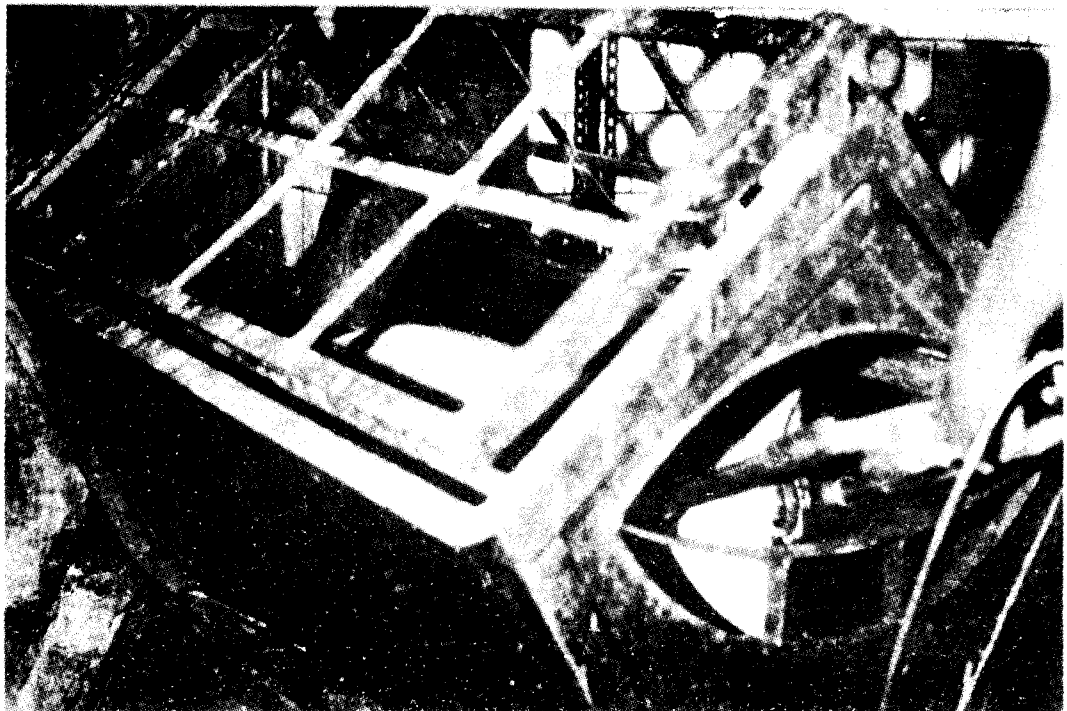
Pig mortality is very low (0.1%) for short journeys limited to 100 km, but increased to 0.3 to 0.5 % for journeys beyond 500 km.

Recently attempts have been made to study the behaviour pattern of meat animals with a view to improving preslaughter handling. In pigs there is tendency to fight when awaiting slaughter. The stress sustained in transport and handling arise during loading and unloading, causing production of dark meat. Tranquillizing drugs are effective in preventing fighting and struggling; and may reduce the incidence of exudative meat, injury and death.

Pigs, delivered from the market or farm arrive at the slaughter-house and are placed in the lairages. Proper resting of the pigs at the lairage during the preslaughter stage is quite useful as it ensures perfect bleeding at slaughter. It is advisable that animals should be rested and watered before slaughter to avoid the effect of stress. Stress severely affect the quality of meat, thus producing pale, soft and exudative and dark, firm and dry meat. The period of resting allowed at the lairage



Pigs in Lairage



varies between 12 to 24 hours, with a maximum of 36 hours. Lairages should have shade, ample water supply and well drained floor sloping towards the drains. It should be connected to the slaughter house only by a long straight and narrow race.

Fasting in pigs helps in depleting glycogen reserves in muscle. It also reduces the amount of undigested food and faeces in the intestinal tract and improves the keeping quality of the meat. The stock should be fasted for 12 hours, but have access to clean water in pens for 16 to 24 hours prior to slaughter. Feeding of pigs with sugar solution at the rate of 3.4 litres containing 1.8 kg of sugar when rested overnight, has given beneficial results in minimizing the carcass weight.

11.1.2 Death of the animal

D.P. Chatterjee, Government Pig Breeding Farm, Haringhata, West Bengal, (INDIA).

- (a) **Stunning:** Humane slaughter can be achieved even under the most primitive conditions by the use of stunning. It can be done either by electricity or by captive bolt instruments. Electric stunning involves the use of brine soaked electrodes applied on each side of the pigs face, by means of which the electric current is passed. A voltage of not less than 250 milliamperes, assuming 50 cycle per second alternating current is used. An electrocution fit is caused, with anaesthesia lasting for about 60 seconds. Therefore, the pig must be stuck during the first 30 seconds.
- (b) **Bleeding:** Pigs should be stuck within 10 second of administering the anaesthetizing current as short stunning-sticking interval reduces blood splash.
- (c) **Dressing:** Carcass dressing requires the skill of the slaughterman. Contamination on the carcass at this point is a hazard. Clags of caked dirt and faeces can deposit contamination on large areas. Pigs are not skinned after bleeding. They are placed into hot water (138 to 142°F) and soaked to soften the hair and then removed for scraping. Scraping is normally carried out by a dehairing machine. The pig is removed from this machine and given a final scrape by hand. Larger meat plants and bacon factories cause the pig to pass through a singeing machine, singes any remaining hairs from the pigs and this process has an added bonus, sterilises the outside of the pig. The dressing is done either by line dressing or by conventional dressing.

Evisceration should be done as quickly as possible after bleeding. During dressing operation edible and inedible offals are to be removed. The dressing percent of the pigs can be calculated as follows:-

$$\text{Dressing percent} = \frac{\text{Dressed carcass weight}}{\text{Live weight}} \times 100$$

- (d) **Cutting:** The pig carcass may be cut and utilised in a number of ways. The side is divided into shoulder, middle, leg etc.

Head: Extensive use is made in manufacturing of meat from the heads of pigs. This consists of mainly of the flash from the lower jaw, which can readily be removed fresh.

Middle: This is handled in a number of ways:

- i) boned out, derinded and partly defatted and cured as a piece into bacon;
- ii) divided longitudinally into back and belly, the back being cured for bacon and the belly either cured or used in comminuted products like sausages, pork pieces, canned meats;
- iii) lion removed for sale as a fresh pork, and the remainder either used as a bacon.

Shoulder: This part of the carcass is heavily laced with intramuscular fat. It is normally handled in two parts, the upper or collar, and the lower which contains the foreleg referred as the ham or picnic. The collar is most frequently used in comminuted products. the picnic is less fatty and if desinewed correctly may be used for curing.

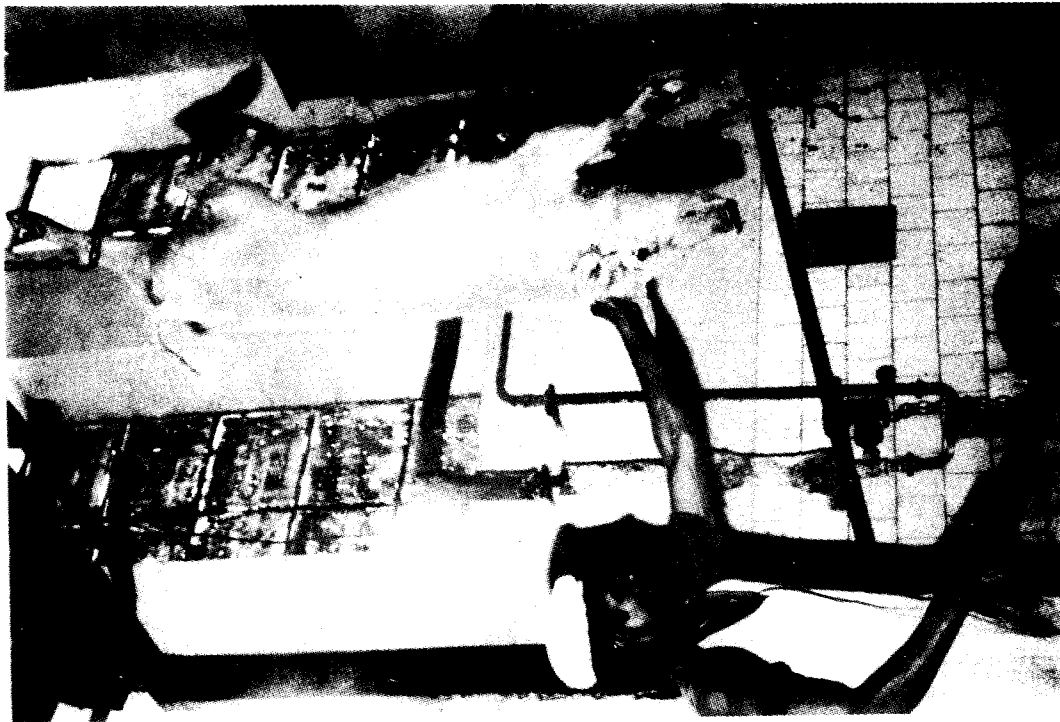
Leg: Leg meat is invariably cured and converted in to ham.

11.2 Slaughtering Technology of Pigs

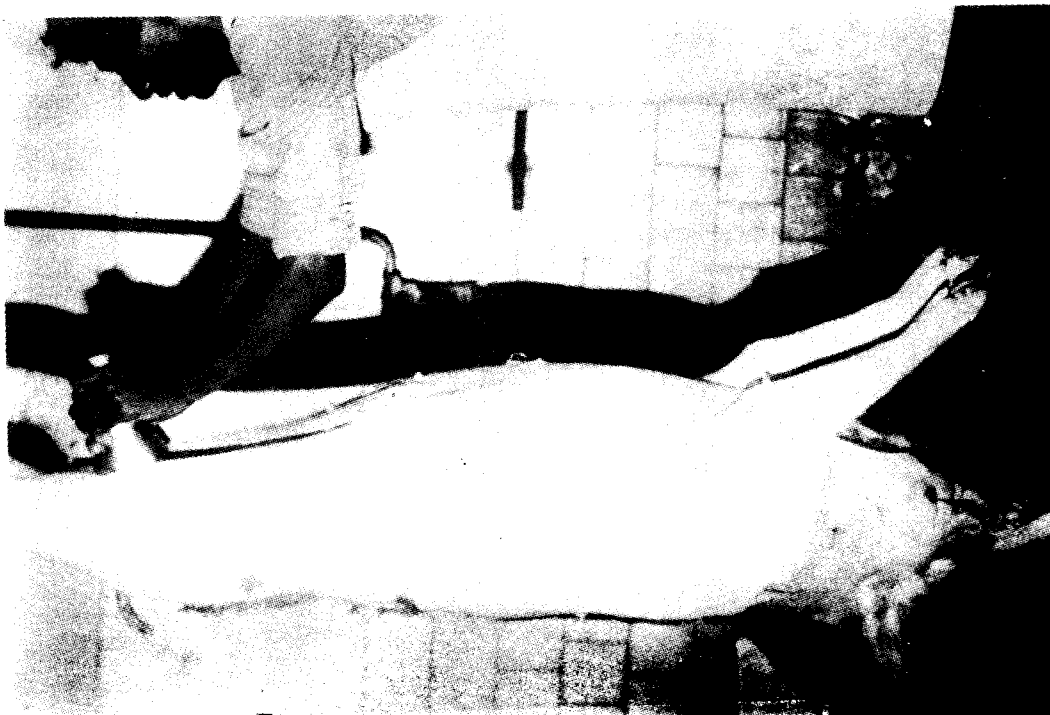
Dr. G.S. Singh, Deputy Commissioner (SH&BF), Ministry of Food Processing Industries, New Delhi, (INDIA).

11.2.1 Pre Slaughter Care of Pigs

Transport and holding of pigs before slaughter are the most important aspects of pre-slaughter care.



Sticking of Pig



Dehairing by Hand Scraper

Stress factors emerge when they are penned before slaughter and aggressive instincts are amplified in slaughterhouse conditions. Therefore, they should be slaughtered by giving 12-24 hour rest. Holding them for 12-24 hours before slaughter has some beneficial effect on the quality of meat. However, over crowding in the lairage should be avoided. Clean dry straw on the floor help them to settle down. The stands must be removed and the pens cleared out before another batch is held in the pen. Every efforts should be made to handle them without excitement. Clean ample water should be provided. Pig under stress produces pale soft exudative (PSE) Pork which lowers the quality of meat. Rest is necessary at lairage, as stress increases the possibility of blood splash also.

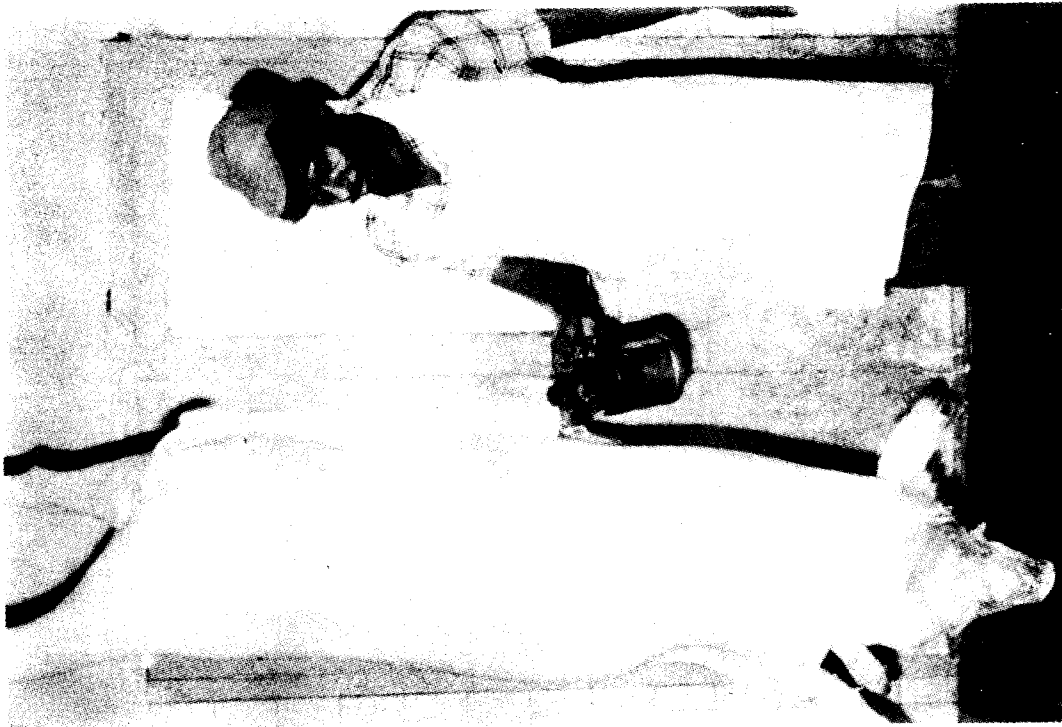
Water sprinkled from overhead on the restraining passage helps to calm pigs down. This also helps in cleanliness of pigs before slaughter. Impatient unloading at the time of transfer of pig from vehicles should be avoided and should be allowed the dignity of slaughter with patient handling.

11.2.2 Stunning

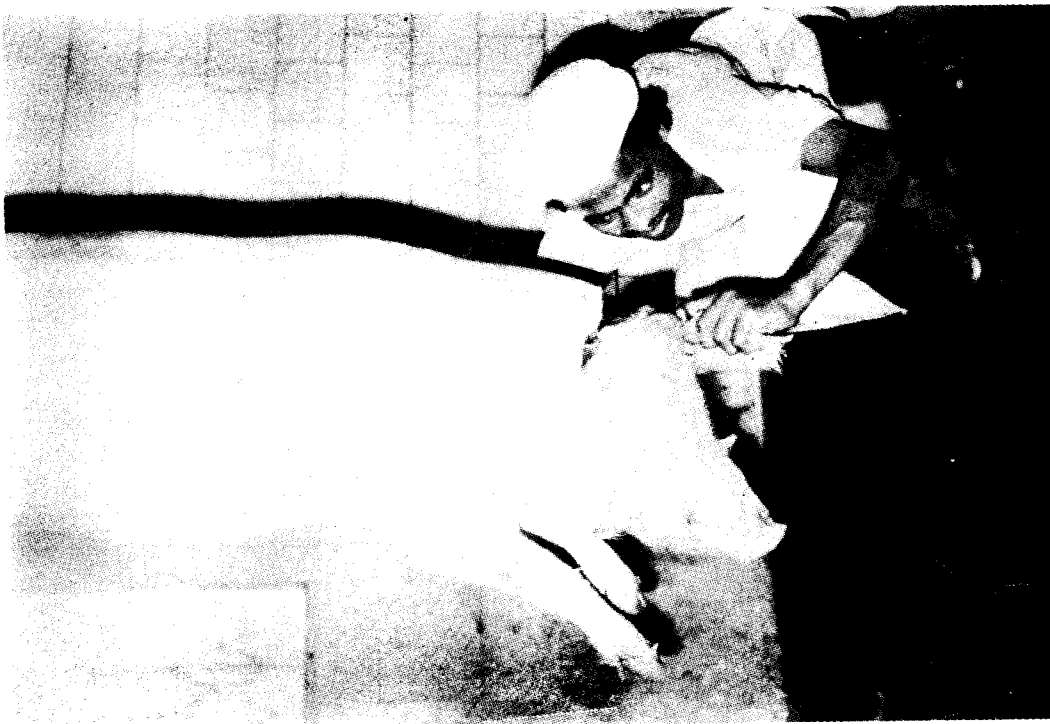
Pigs are highly susceptible to stress. Therefore stunning of pigs is continuously being developed. Auto electric stunner which is highly transistorised according to shape and size of pigs function quite satisfactory. The electrodes should be properly placed on either side of the head at horizontal line of the ears. the electrode pad should be dipped in to weak saline solution to improve conductivity through skin. The surface skin over the head should not be wet as this can short circuit the voltage which must complete the path through the brain. The voltage is 80 volts 50 cycle not less than 50 milliamperes and the electrodes should be applied to minimum period of 10 seconds. The criteria maintained that animal should be unconscious for one minute. Another method which is available for stunning of pigs is conveying them through a tunnel filled with carbondioxide gas. It takes about 45 seconds for the hog to pass through the tunnel. The level of carbondioxide is kept at 68 to 70 percent concentration through controls. Sublimation of dry ice is used to supply the carbondioxide gas. Third method pithing or captive bolt is also available by which pigs can be made unconscious. However, out of the Electrical, chemical (carbondioxide gas) and mechanical, electrical stunning is better and common. Pigs should be shackled elevated and stuck immediately after stunning. A time of 10-20 seconds should be achieved after removal of electrode to improve bleeding and minimise blood splash.

11.2.3 Sticking

The sticking knife should be inserted on the centre line of the throat in front of the breast bone and then pierce through heart. The knife should not go in so far as to penetrate the shoulder. The stick



Singeing of Pig Carcass



Removal of Head from the Carcass

cut should be as small as possible to reduce the ingress of dirty scalding water. About 3 minutes is the proper bleeding time and it should not be sent to scalding tank before 6 minutes period of bleeding because until there is proper bleeding, the keeping quality of the meat is lost.

11.2.4 Mechanised Pig Unit

Let us look at the diagram of pig slaughter house pig unit (Fig. 11.2.4.1). In such plants all the functions are some times done by complete mechanical sequence.

Maximum degree of sophistication has been achieved in pig slaughter in developed countries.

11.2.5 Bleeding

The conveyor controls at the time of bleeding, 6 minutes is desirable. Depending upon the weight of the animal 2.5 to 3.6 kg blood is obtained.

11.2.6 Scalding

This is necessary to remove pig hair from the follicle, and also surface sterilization of the carcass. The time temperature parameters are 5.5 - 6.5 minutes from 61°C(142°F) to 59°C(138°F).

Fully automatic converization is installed in a number of high throughput plants. The shackled pigs are carried by conveyor from sticking point through the dehairing position. Bleeding is continued and subsequently scalding should also be accurate.

The conveyor lowers the carcass in to the scalding water and pulls it horizontally.

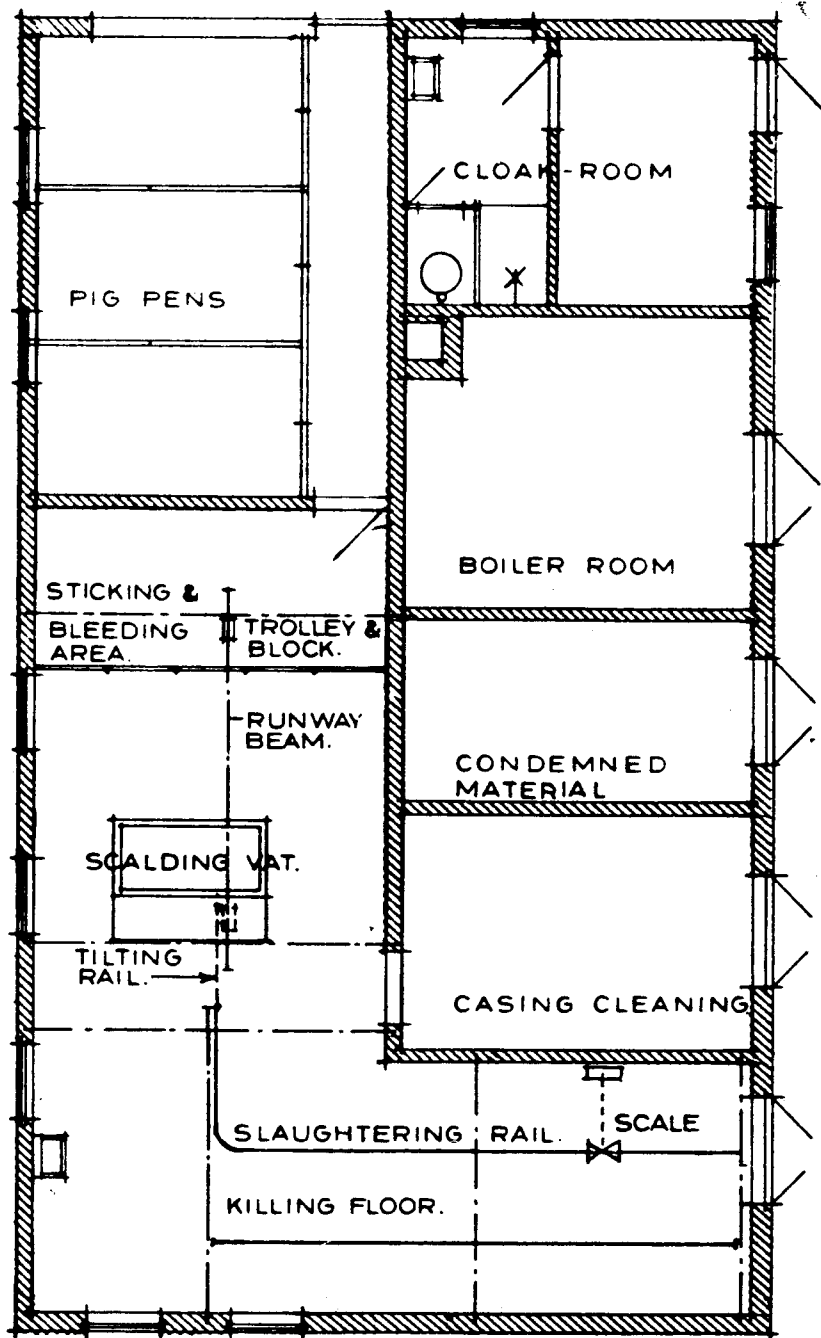
11.2.7 Bacterial Contamination in scalding Tank

Scientists and Engineers have held the view that there is element of bacterial contamination in scalding tank which affects the keeping quality of pigs. Often lungs are condemned owing to absorption of dirty water from scalding tank.

Now in Sweden and Holland, to avoid it vapour or hot water spray is applied. the cost of such method is high for commercial operation. There is evidence that bacterial count dramatically reduced. Lungs need not to be discarded.

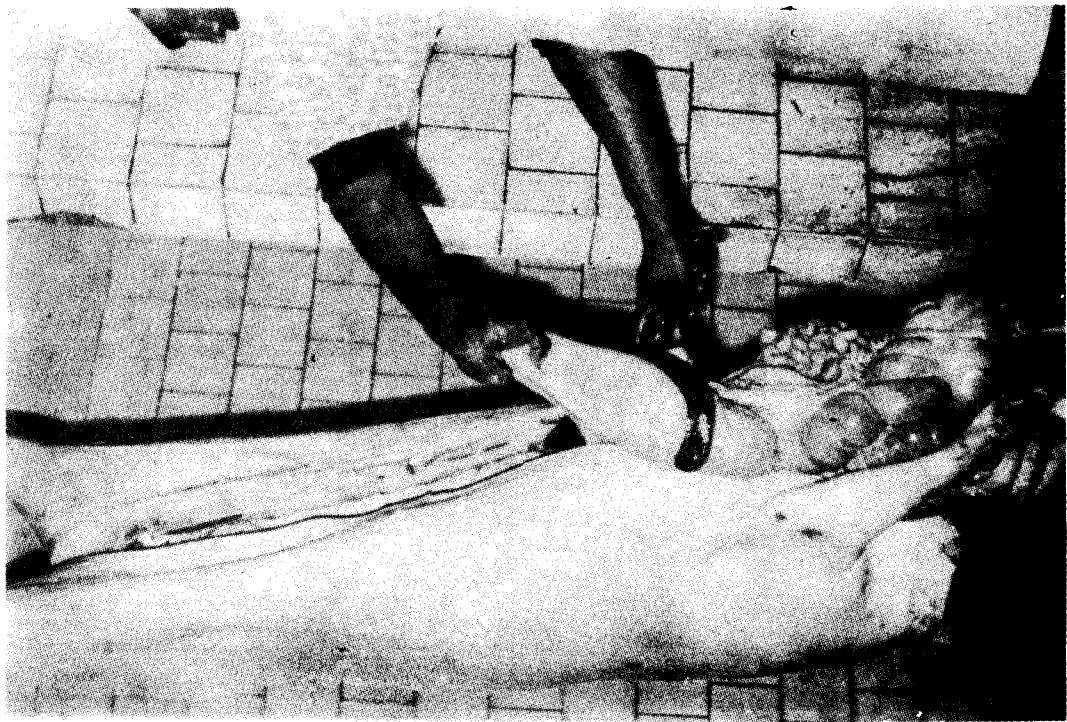
11.2.8 Dehairing

It is done in simplest form by a specially formed hand scrapper.

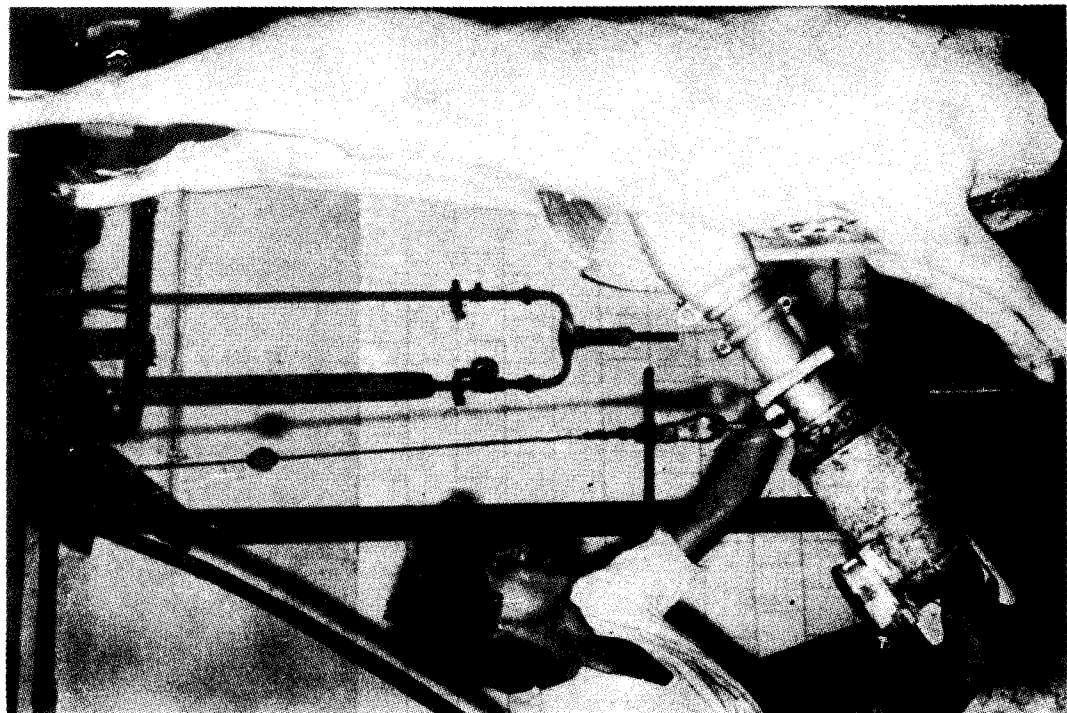


Plan 1:1000 (For 20 to 30 animals per day)

Fig. 11.2.4.1 Pig Slaughter House.



Evisceration of Pig Carcass



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Longitudinal cutting of Carcass

Machines of various sophistication are sometime being used. The transverse machine is commonly used in Europe or even in Asian countries, and the straight through or longitudinal in shape machines are common in U.S.A. This machine rotates under a predetermined cycle. Pigs are ejected by various means in completion of the cycle. It is U-shape machine. The drums when rotates, it not only remove hair but screw action takes pig forward. The direction of the rotation of the drums is opposite, resulting reverse rotation to other. This further improves the finish of the pigs.

11.2.9 Finish

Still hairs are removed by scraping. Modern plants with high mechanisation include machinery for polishing and brushing the carcass.

11.2.10 Gambrel

The carcass is placed on the gambrelling table leaving dehairing machine.

11.2.11 Singeing

If bacon is to be cured from the carcass singeing is done for 15 seconds. It removes.

- 1) remaining hairs
- 2) Sterilize the cuticles
- 3) Improve the keeping quality.

11.2.12 Evisceration

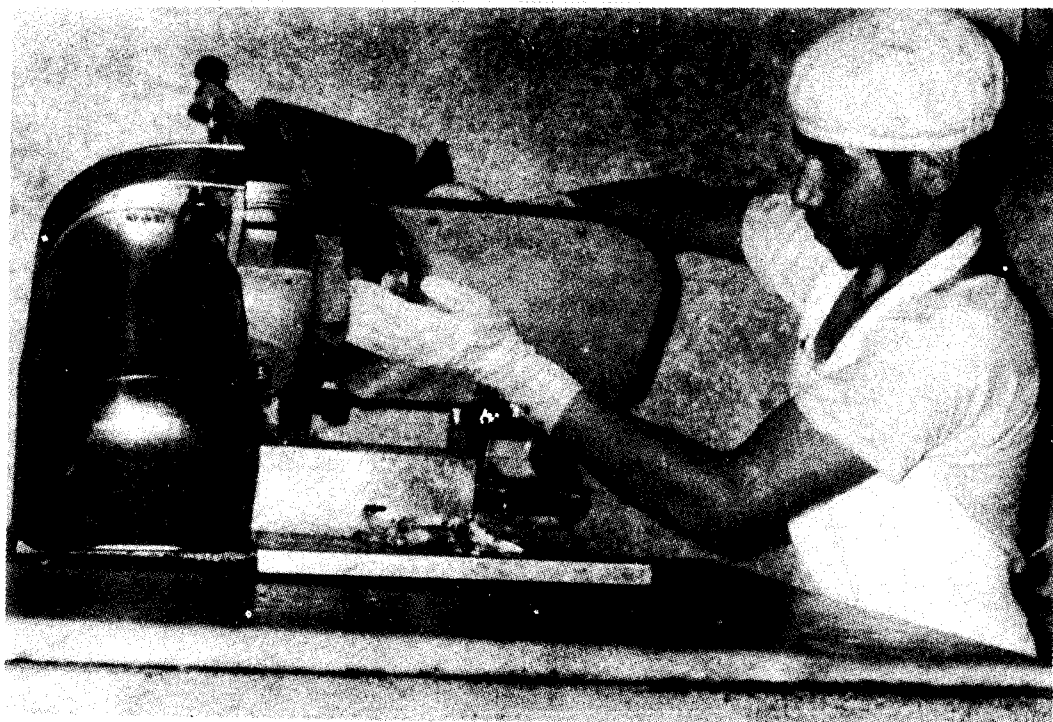
When intact the whole carcass is washed. Head is cut and dropped. The aitchbone is split to prevent the contamination from the guts. Belly is accordingly opened. The stomach and abdominal mark is removed and placed separately from pluck for inspection.

The carcass is split longitudinally down to the centre of the spinal cord from the aitchbone to the head and sent to the chiller.

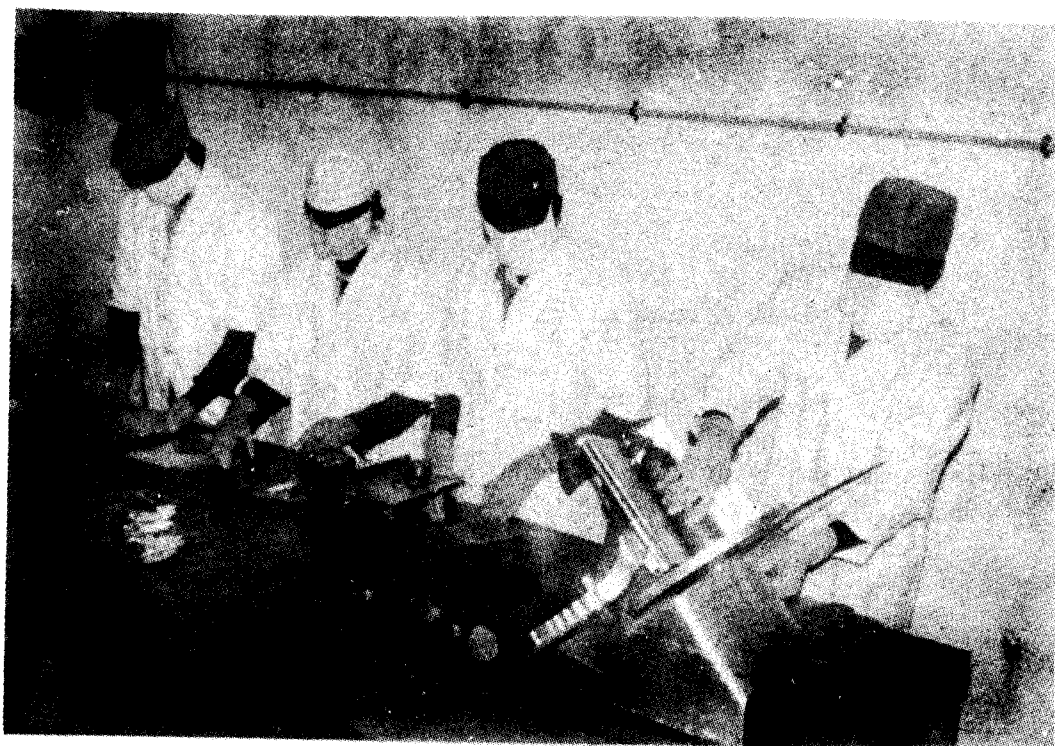
11.3 Processing of Pork and Pork products

Dr. V.P. Singh, Professor & Head, and Dr. R.S. Yadav, Associate Professor, Department of Animal Production & Management, Veterinary College, Jabalpur-482001, (INDIA).

Pork is sold as fresh, cured, smoked and canned. It is processed alone or in combination with other meats, such as sausages and ready to serve meat.



Machine used for Slicing Bacon



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Salami Preparation in Bacon Factory

The empirical observation that salting would preserve meat without refrigeration was made several thousand years ago. Salt is not only a preservative, but also a flavouring substance. Its preservative effect is enhanced in conjunction with sodium or potassium nitrites. Nitrates are primarily used to develop colours, although they have some bacteriostatic effect also. The various forms of salted pork, which are widely regarded as attractive, continue to be extensively prepared. Curing is done either by pickling or dry curing. The curing rooms are usually maintained at 1.7° to 4.4°C. Curing in pickle may be with plain pickle (salt solution), in pickle containing nitrate and/or nitrite, or in pickle to which sugar as well as nitrate and or nitrite (sweet pickle) and other ingredients have been added. Same ingredients are used in dry curing. Pork cuts like ham, bacon and shoulder cuts are used for preparing cured products.

Wiltshire Cure (Bacon cure)

After slaughter, the carcass is singed and scraped and sides are trimmed. The trimmed sides are chilled to 3-7°C. The brine (pickle) is pumped into the sides. The sides are either sprinkled with dry salt or placed in a tank of brine and then the sides are removed and stacked for some time in a maturing celler at 3-7°C for 7-14 days or longer. During this period, known as maturation, the sodium chloride, the nitrate and nitrite become more evenly distributed throughout the musculature and the typical colour and flavour is developed. A relatively recent development in the preparation of bacon is sliced curing. This process gives a uniform product in less than a day instead of 10-21 days of the traditional process.

Ham

The pig carcasses are quickly cooled after slaughter and two days later curing is begun. The brine is injected by arterial pumping (6 percent of the weight of the ham). The hams are kept covered in brine for two to three days. The hams mature on racks for about six days at curing temperature and are deboned, cut and exposed briefly to cold smoke, then heated and processed in cans.

Dry Curing

In this method, the surface of meat is rubbed thoroughly with the dry curing mixture and then the meat is placed in the vat. Each tightly packed layer of meat is sprinkled with the curing mixture. The bellies may be cured in open vats, or they may be dry cured for a short period, and then pickle cured. After curing, the hams are smoked at regular intervals at about 26.7°C for approximately 30 days and then aged for 7-11 months at ambient temperature.

Emulsion Curing

In processing sausages, emulsion curing has been employed in recent years. This involves cooking the meat emulsion, immediately after adding the curing ingredients, for 90 minutes at 75°C.

Smoking

Smoke, generally produced by the slow combustion of saw dust derived from hard-woods inhibits microbial growth, retards fat oxidation and imparts flavour to cured meat. Smoked pork and pork products are high calorie products of good eating properties and delicate juicy texture. The smoking causes dehydration and fermentation. Various compounds are known to be found in smoke. The smoke ingredients penetrate into the thickness of the product, impart a specific taste, appearance and colour and odour to it. Smoked products intended for long storage as lower moisture content creates unfavourable conditions for microbial developments.

11.4 Quality, Effect of Processing & Handling of Meat

Chandra Shekher Sahukar, Meat & Meat Products Division, Ministry of Food Processing Industries, New Delhi, (INDIA).

11.4.1 Pork, Quality and Comparison with other Meat

Meat is defined as the flesh of the animal used as food, it is often widened to include, as well as the musculature organs such as liver, kidney, brains and other edible tissues. The bulk of the meat consumed in India is derived from Sheep, Goat, Cattle, Pigs and Poultry. The quantity or yield of dressed meat obtained per animal depends largely on its live weight, size, breed, and also on topographical and climatic conditions. The average dressing yield in terms of the original live weight for Indian beef cattle ranges from 35-40 percent, for sheep and goats 40 percent, and for pigs 60-65 percent. The carcass of the animal is divided to produce cuts. The value of meat depends to a great extent on the appearance and shape of these cuts. The different beef and buffalo cuts are round, rump, sirloin, short loin, flank, rib, short plate, square cut chuck, brisket and shank. Mutton and goat meat cuts are legs, loins, racks, breasts, shanks and shoulders. Pork cuts are ham, shoulders, loins, tender loins, spareribs and butts.

Type and quality of Meat

Fresh meat is usually of a light pink colour, firm and fine in grain, with a smooth velvety touch and is full of sap. The fat is well distributed. On storage meat becomes coarse, dry and stringy, sticky to touch and darker in colour.

Meat from young animals tends to be pale and almost devoid of fat. It may lack flavour but is tender to eat. Flavour depends particularly on fat, due to volatiles that are species distinct and increase during growth. In older animals there is more fat within and between muscles, reducing the tenderness. Best meat is reported to be obtained from sheep, goats and pigs between the age of six months and one year, and cattle between one and three years.

According to the species, meat is differentiated into beef mutton, pork, goat meat, buffalo meat.

Beef is usually bright red with a raspberry tinge, with a fine grain and velvety to touch. It is well covered on the surface with fat which is considerably marbled. Raw beef has a weak, characteristic odour, which becomes stronger on boiling. The colour of boiled beef is gray in the cut. The fatty tissue is light yellow, hard, and of crumbly consistency. Meat from old and inferior animals is often darker, coarse, fibred and dry, with a more yellowish fat.

Buffalo meat is dark red when slaughter warm and becomes bright red on chilling due to formation of oxyhaemoglobin. The muscular tissue is coarsely fibrous. The odour of buffalo meat and fat resembles that of musk, and the fat is strikingly white, and is drier and less sticky than in beef.

Mutton is light to brick red in colour, bright and glistening. It is moderately firm in consistency having white, hard, clear and abundant fat between the muscles and under the skin. The fat is odourless and tallow like, setting quickly and becoming crisp and firm. Mutton cuts are small and the lean meat is bright pink with a white brittle and flaky fat.

Goat meat is dark red with a brown tinge and coarser in texture. It has a characteristic "Goaty" odour and may have hairs adhering to its surface. The fat is little yellowish and does not set so firmly as mutton fat.

Rabbit meat is pale, pink and becomes white on boiling.

Horse meat is darker than meat of other animals. After storing in air, its colour becomes intensely dark red with a blue tinge due to metmyoglobin formation. The fatty tissue ranges from yellow to lemon yellow and has a soft greasy consistency.

Camel meat is coarse, thick and disagreeably sweet due to presence of glycogen.

Poultry meat is firm fine fibred, there is little intermixing of

fat with the fibre. The colour is pale to red. The fat is soft and oily.

Pork varies in colour according to the age and conditions of nutrition of animal and the part of the body. It is generally whitish grey, pale red, pink-red, grey red to dark red. Boiled pork has a very delicate texture and is white in its cut. The flesh is firm and fine, well marbled. The fat is pure white finely granular, soft, more oily or greasy to touch than that of beef and mutton. It envelopes the larger groups of muscles and is considerably intermixed with the fibre. The bone marrow is soft and pink red.

11.4.2 The eating quality of Pig Meat

Traditionally, meat has been seen as desirable components of the diet and of high nutritional value. The quality of meat depends upon its nutritive value, its easy digestibility and palatability. The end product will be judged on its merits by the consumers, who will judge it from several aspects. The buyer, usually a house wife, buys meat not only for its specific meat characteristics, such as colour and weight of the cut, but also on its suitability for children, the specific meal, the price and choice of vegetables.

- (i) **Colour:** The colour of pork is generally whitish grey, pale red or grey red to dark red. The colour varies according to age and conditions of nutrition of the animal. The colour of a freshly cut and exposed surface of meat is due to reduced myoglobin. On exposure to oxygen, myoglobin is converted into oxymyoglobin giving rise to bright red colour which is desired by the consumers. On further exposure the oxymyoglobin gets converted into metmyoglobin leading to dark brown colour. The pig meat is very pale due to the relative absence of myoglobin and chemical change in the pigmeat. The colour of cooked, uncured lean meat depends upon the nature and amount of myoglobin derivatives. During cooking, the colour of the meat changes gradually from deep red to pink to lighter tint.
- (ii) **Water holding capacity and juiciness:** Water holding capacity of uncooked meat influences the juiciness of meat after cooking. The fall in post mortum pH reduces the water holding capacity, Conditioning of meat increases its water holding capacity. There is shrinkage of meat on cooking to an extent determined by method, time and temperature of cooking.

Juiciness in cooked meat has two organoleptic components. The first is the impression of wetness during the first few chews and is produced by the rapid release of the meat

fluid; the second is one of the sustained juiciness. The good quality meat is juicier than poor quality meat.

- (iii) **Texture and Tenderness:** Texture and tenderness are the most important characteristics which determine the consumer preference. Texture as seen by the eye, the size of muscle bundles and of the connective tissue envelopes of muscle bundles. The tenderness depends upon the amount of connective tissue present in the muscle portion. The pork contains little connective tissue as compared to other meat. Tenderness is affected by preslaughter and post slaughter factors. The preslaughter factors includes breed differences, age at slaughtering, feeding and management practices. The postslaughter factors include the length of time and the temperature of storage after slaughtering, method of trimming and cutting, methods of cooking and the addition of tenderizing agents. Meat stored at 0-5°C after slaughtering, tenderness decreases during the first 24 hours at the setting of rigor mortis and then increases gradually. Freezing and frozen storage have a tendering effect. Pressure cooking increases tenderness with detrimental changes in the biological value of meat proteins. However, no lowering of the nutritive value of meat would occur at temperature below 100°C.

The use of artificial tenderizers like vinegar, lemon juice, wine or salt and enzymic tenderizing is not new. It was advertently employed at least 500 years ago by the Mexican Indians when they wrapped meat in pawpaw leaves during cooking. Sodium chloride and other salts have a tenderizing action on meat. Preslaughter injection of proteolytic enzymes to the live animals before slaughter has proved to be most effective method of artificial tenderizing. A concentration of about 5 to 10 percent of tenderizing enzyme is injected half an hour before slaughter at the rate of 0.5 mg/lb body weight.

- (iv) **Odour and Taste:** Flavour is a complex sensation, which develops as a result of odour, taste, texture, temperature and pH. The odour and taste varies between the individuals and influenced by extraneous factors. The taste of raw meat is bland, being only slight sweet, salt, sour or bitter.

The fresh raw meat has a slight odour. Meat from young animals has less odour than from the older one. The meat from young animals fed on a feed containing a high proportion of fish meal may have a fishy odour. Condition, method and time of storage influences the odour.

Taste and odour of meat develops on cooking and it depends on the method of cooking, type of cut, treatment of meat before cooking and spices used. The flavour of cured meat is better as compared to that of uncured meat. Pork is the most frequently preserved by curing, which improves the flavour of cured pork product.

In recent years systemic attempts have been made to introduce micro-organism deliberately in order to produce particularly desired flavours. In the future, it would be possible to enhance and control of odour and taste by the addition to the comminuted product of controllable micro-organism capable of fostering flavour: or even by the preslaughter administration of desired flavour producing chemicals or micro-organism.

11.4.3 Processing and its effect on Nutritive value

the major part of the meat consumed in India is eaten as unprocessed fresh meat. During the past decade a number of meat processing plants have been established. Introduction of processed meat increases the varieties of choices for specific consumer groups, tourist trade, hotel and restaurants. It would also contribute to the economy of the meat industry.

The effect of processing are normally considered in terms of their detrimental effects in the nutrient composition of meat. There are, however some beneficial effects. Meat and meat products are processed to improve their sensory qualities, to destroy pathogenic organisms and for preservation purposes.

The detrimental effects of processing on nutritional quality of pork and pork products are - shrinkage and loss in juiciness, loss of nutrients including vitamins and amino acids etc. during thermal processing, freezing and storage.

A significant loss of flavour has been reported, if bacon is stored at 45°F for 4 to 6 weeks. If proper sanitation and hygienic conditions are not maintained during the processing process, even at cold storage meat get spoiled. The spoilage of meat can be prevented by using sanitation in all handling operations, particularly in chilling room. The use of ozone, carbon di-oxide, ultraviolet light and ionizing radiations in storage rooms has been recommended.

Although prediction of nutrient loss is not an easy matter. Empirical studies have shown that because of the close relationship between the factor dependence of quality factors such as colour, texture, vitamins and flavour, processes optimised for organoleptic quality attributes are

also optimal for nutrient retention. In most advanced meat processing industries, meat processing practice is already optimised for organoleptic properties. In recently developed processing methods, the processing loss of nutrients due to well established commercial practices is reduced. These include microwave thawing and cooling, aseptic canning, irradiation etc.

11.4.4 Hygienic Handling and Transport of Meat

The hygienic handling and transport of meat has significant value from economic, nutritional and public health point of view. It will also ensure the transportation of meat over long distance and for bridging over the period of scant production. Meat handling and transportation from abattoir to market in hot condition is generally done with rapidly speed. There is hardly any regulations operating regarding hygienic transport of meat. In major cities, the abattoir authority provide covered fly proof vans to the butchers to transport meat for its distribution from slaughter house to the retail outlets. In small places, every conveyable methods are adopted for transport of the meat. The private exporters or State Meat Transport are engaged for the export trade in meat. In every vehicle used for the carriage and delivery of meat the basic hygienic requirements during all stages of transport should be maintained to prevent meat from spoilage.

Constructional Requirements

The internal transport of meat is done in enclosed vehicles, specially designed to transport meat. The vehicle should be so constructed or covered in as to prevent the access of flies and to exclude dirt and dust. The roof should be finished internally with a material that can be easily cleaned. The covering of all sides of the platform type of vehicle should be waterproof.

If meat is transported without containers, the floor of the vehicle should be constructed of hard material to prevent the absorption of grease and blood. The floor should have a nonslip surface. Ribbed or studded aluminium alloy flooring is suitable for this purpose, as to facilitate drainage, combines strength with lightness and is easy to clean. Galvanized sheeting also gives the satisfactory results.

The walls of the vehicles should be lined with flush, noncorroding panels, the joints between each panel being adequately sealed to form a smooth surface. To simplify cleaning the angles are eliminated by covering the junctions of the walls, floors. Zinc, aluminium alloys and galvanized sheet are more suitable lining of interior walls. Non alloyed aluminium can be used after painting.

Duckboards or racks should be sectional and if wooden should be made of hard wood. They must be kept clean and in a good state.

Metal racking is stronger, more durable and more easily cleaned.

Design and cleaning of vehicles

Vehicles acquired for transporting carcass meat should be specially designed for the purpose. Other vehicles should be adapted for hygienic transport of meat. Carrier Vehicles of other goods should be properly cleaned before meat is loaded.

The vehicles, containers and equipments should be properly cleaned at regular intervals. An ample supply of hot and cold water, hose pipes, detergent, bass or wire brooms and buckets should be available at slaughter houses and bacon factories to enable thorough cleaning of vehicles.

Loading and Unloading of Carcass Meat

The process of loading and unloading should be carried out in such a way that the meat is not soiled. Vehicles with specially constructed low slung chassis have advantages for some specialised operations. The loading and unloading operations should be carried but by experienced personnel. Mechanical loading devices minimise handling and the need for walking on the floor of the vehicle.

Transport of certain types of meat

Meat which is not adequately wrapped should be hung. Containers for use with unfrozen offal should be fashioned so as to exclude contamination from the floor of vehicles and loading yards to make for easy cleaning. Metal containers are best as it can be cleaned as soon as the offal has been taken out. Raw meat, offal and casings should not be allowed to come into contact with open pack meat products.

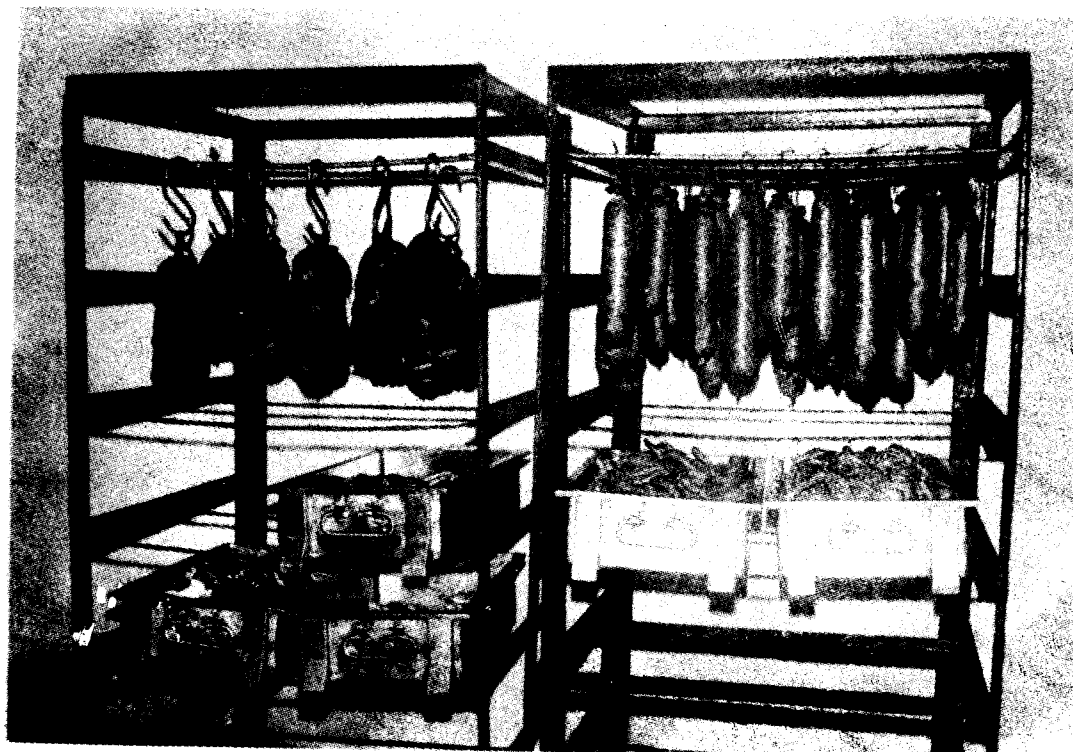
Delivery from Butcher to consumer

The meat should be adequately wrapped or in covered containers. If covered containers are not available, it should be carried in suitable metal or plastic trays. The special care should be taken to protect meat and meat products from contamination during the transport.

Personal Hygiene

A high standard of cleanliness in the handling of meat should be maintained by all persons engaged in its transport.

The hands are important in the spread of food poisoning organism from the handler to meat and from meat to the handler. The bacteria on the hand can be passed to cloths, and other equipments. The handlers can add germs to meat from their hands soiled by excreta from the bowel



Pork products in Chilling Room



Pork products of Bacon Factory, Ranchi

and by secretions from the nose or throat. The care of hand is important. In bacon factories and slaughter houses, there should be good facilities for handwashing, including an adequate number of wash basins with hot and cold water, soap and nail brusher. The nails should be kept short. Towels used for drying hands must be clean.

All persons engaged in the handling of meat should wear suitable protective clothing made of material which can be easily washed and kept clean. The clothing should be so designed as to give adequate protection both to the wearer and the meat. Persons carrying on their shoulders carcasses or quarter of meat should wear protective covering. Light coloured cotton caps or shoulder pads covered with impervious material are useful adjuncts. Protective clothings should be clean. Good habits should be encouraged. Illness even if minor, should be reported particularly if there is diarrhoea, vomiting, sore throat or skin infection.

Proper handling and personal hygiene prevents the contamination of meat by bacteria during transport. The chances of bacterial food poisoning, zoonotic diseases could be prevented by careful handling and transport of meat at all stages of production and at retail shops.

11.5 Packing, Consumer preference and Marketing

Dr. D.P. Sinha, Chemist, Government Bacon Factory, Ranchi (Bihar) INDIA.

11.5.1 Packing of Pork and Pork Products

Packaging ensures the safe delivery of pork and pork products to the consumers. Packaging maintains the quality of meat products, by delaying the onset of spoilage. The proper selection of packaging materials and techniques can help in protection, preservation and successful marketing of pork and pork products.

Fresh Pig Meat

A large quantity of meat is sold through butcher's shops after immediate removal from the carcass, increasing quantities are butchered at points remote from the retail outlet. Such meat may be packed in large "primal" packs for further cutting at the point of sale or it may be cut in to retail size units for direct sale to the consumers. Fresh meat is packed to maintain colour, texture and moisture.

Cellophane coated with nitrocellulose has been used for wrapping fresh meat for long time. The polystyrene trays with a transparent film overwrap allows the satisfactory storage of meat for 10 days at 0°C. Vacuum packaging of fresh meat increases the storage life. Boneless pork joints are shelf stable for a period of two weeks at 0°C in vacuum packed condition.

Cured meats

The right choice of packaging material is important for packaging of cured meats in order to maintain the colour. Short term storage of cured meats can be done by overwrapping in polyethylene film. Ham and other large uneven cuts of cured meats can be shrink packaged in polyvinyl chloride (PVC) copolymer. Vacuum and gas packaging is the right choice for long term storage of sliced bacon in laminate pouches made up of polyester/polyvinylidene chloride (PVDC) or polyamide or metallised polyamide. Product packaged by this technique has a shelf life of 3 months at 0-4°C and 6-8 months at -18°C.

Frozen meats

Frozen pork and pork products are packed in moisture proof cellophane and polyethylene coated polyester, which extends shelf life of frozen pork chops for 3 months.

Precooked frozen meat products

Hamburger and other precooked frozen pork products are packaged in the boilable bag consisting of polyester/medium density PE laminate. These packaging materials can withstand boiling for about 20 minutes and makes excellent seal.

Thermoprocessed meat products

A wide range of cured sausages is now prepared and marketed in sleeves of low oxygen permeability. Corned pork and liver sausages are hermetically sealed and processed in metal cans to preserve the desirable flavour, texture, and appearance. Pork luncheon meat and chopped pork are vacuum packed in a polyester film/aluminium foil/polyolefin film laminate pouch autoclaved and put in printed board carton. These packaged products are shelf stable for two years at room temperature.

Economic constraints within the meat processing industry demand the utilisation and proper packaging of all possible parts of the carcass in a manner which will yield greatest return both to the processor and the consumer without affecting the nutritional value.

11.5.2 Consumer Preference for Pork and Pork Products

It is only with the diversification created by modern food processing industrial technology, that the choice between alternatives became real. The rate of consumption of a large quality of pork and pork products has been related to psychological dimensions such as preference. The consumer preference is based on the desired frequency of serving, availability, composition, either in terms of the major nutrients (fat, protein

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2. ALIGARH : 46-Gandhi Market,
3. KANPUR : 18/184, Mall Road,
Opp. Phool Bagh,
4. BAREILLY : A.S.C. School Canteen
Bareilly Cantt,
5. NAINITAL : The Poplarn,
(Ph. No. 2273)
6. LUCKNOW : 37-Hazratganj,
(Ph. No. 45174)
Central Command Canteen
Usman Road,
7. NEW DELHI : H-Block, Tropical Building,
Connaught Place,
(Ph. No. 3320628)

and carbohydrate) or as carriers of vital or necessary nutrients. The various measures serve as a way of explaining and if possible predicting consumption.

The consumer preference in metropolitan city like Bombay, based on percentage of the actual sale of products over the total sale of all products, indicated sausages to be most popular (40-50%) followed by fresh pork (30%) and ham and bacon (15-20%). The canned products sale is less than 5% of total sale. The consumption of pork and pork products is comparatively restricted to small section of the population. The poorest urban village sections and tribals consume fresh pork and a small section of sophisticated urban population consume pork and pork products.

11.5.3 Marketing of Pork and Pork products

In the cycle of pig production, marketing holds a vital place. The marketing of pork products are still in infant stage and a number of problems require to be solved. Some of the points requiring consideration are purchase policy, arrangements for the collection of animals and their transport, shrinkage and transit losses and selling policy. Many of the farmers engaged in pig production are from the poorer sections and experience difficulty in transporting their animals to the factory. This problem can be solved by establishment of recognised collection terminal points and bacon factories should collect the pigs from the center. In India lack of marketing facilities are available for sale and distribution of pork and pork products. The formation of adequate marketing facilitating services (advisory, training and applied market research) would increase the demand and sale of pork and pork products.

There is a great potentiality for the diversification of production in the form of ham, bacon, sausages, canned meat etc. This will make available cheap wholesome meat and processed meat products to all sections of people including consumption at hotels and restaurants, Hostels and Clubs, Airlines, Defence service canteen and mess, Departmental stores and Superbazzars.

11.6 Byproducts Arising from Pork Processing Industry

J. Sahoo, Associate Professor-cum Senior Scientist, Animal Products Technology, Faculty of Veterinary Science & Animal Husbandry, SKUAST, Srinagar-190001, (INDIA).

During the slaughtering of pigs and processing of pork into other products, many byproducts became available and can be used commercially. Slaughtering operations on a large scale afford the opportunity of efficient utilisation of these byproducts. The greater utilisation of these byproducts would contribute to the economic working of the bacon factories.

Table 11.6.1 : Average weight(g) of the important glands and tissues of different breeds and grades.

Organs/tissues	Middle white (48 kg)	Large white (90 kg)	Large white x saddle back (150 kg)
Blood	1800	2700	4050
Hooves and Hair	675	510	1125
Thymus	84	140	150
Heart	148	252	392
Diaphragm	216	392	216
Lungs and Trachea	618	646	1650
Oesophagus	56	56	
Stomach empty	420	478	1406
Intestines empty	1912	2466	3628
Caul fat	56	140	562
Mesenteric fat	392	1040	1116
Liver	842	2136	2250
Gall Bladder	28	42	28
Spleen	84	98	196
Total viscera	8100	13287	17156

The classification of byproducts differ widely in different regions of the India, depending on local or regional food habits, religious rules or economic situations. The offals from the pig can be divided as follows:-

OFFALS OF PIGS

Edible	Inedible	Pharmaceutical
Head (tongue, brain, ears, lips, snout, head trimmings) stomach, feet, tail, fat, kidney, skin (gelatine), blood.	Hair, casings, blood, bone, hooves, skin (leather), lungs, trachea, gall bladder, stomach contents	Pancreas, parathyroid, pituitary, ovaries, thymus, thyroid, spleen

The average weight of the important gland and tissues vary according to the breed, grade and preslaughter weight of animal (Table 11.5.1).

The edible byproducts are consumed as food items. The head afford the most valuable byproducts and is also used in the preparation of dishes at special occasions. Guts are used after thorough cleaning for the preparation of casings. Casings are various parts of the intestinal tracts of animal and they are utilised in the manufacture of various kinds of sausages.

In edible byproducts can be used as a rich protein source for animal feeding. Bones and other inedible offals are used for the production of meat and bone meal. India is one of the few countries which produce bristles of very high quality. Bristles are mostly obtained from the indigenous domesticated pigs, which are used for manufacture of brushes, carpet paddings etc. The dung and urine of pigs collected for use as fertilizer.

A large number of valuable products used in medicine are manufactured from parts of the animal body, such as endocrine glands. Some important products are pepsin, pancreatin, adrenalin, pituitrin, insulin and thyroid extract. Ovaries yield oestrogen which is used in the treatment of menopausal syndromes and progesterone to prevent abortion. Blood is also utilised in haematonic preparations.

The setting up of carcass utilisation plants in association with pork and bacon factories would offer the possibilities of efficient and profitable utilisation of byproducts of Indian pig industry.

CHAPTER XII

HUMAN RESOURCES DEVELOPMENT

12.1 Training and Development of Skill

Kusum Sahukar, Piggery India Year Book, C-2/333, Yamuna Vihar, Delhi-110 053, (INDIA).

Generation, transfer and the adoption of advanced technology of pig production are three important elements of pig industry. The research of pig production is of no use unless that would be communicated to the farmers effectively. For effective transfer of technology, the extension functionaries working at various levels need regular updating of their knowledge and skills pertaining to pig production and pork processing. Communication techniques should be improved for effective extension programmes. The objective of improving professional competence can be achieved only by arranging regular training, workshop and seminars for the extension workers at all levels. Training imparts knowledge and develop skills in extension workers engaged in the task of transfer of pig production technology.

Objectives of training

- i) To create greater awareness of and to provide new insight into the problems and possible solutions related to pig husbandry.
- ii) For obtaining higher pig and pork production through the adoption of modern technology of breeding, hygiene, nutrition and management.
- iii) To provide the farmers with practice oriented knowledge and skill in the field of pig production and enable them to efficiently utilise the locally available nutrient resources.

Training Institutes.

Training imparts scientific skills for pig production and farmer can learn and adopt practices of advanced technology of production. Since the introduction of professional agricultural extension system in the country, training has become a joint effort of State Agricultural Universities, Indian Council of Agricultural Research, Government Pig Breeding Farms, Government Bacon Factories, All India Coordinated Research Project on Pigs, State Departments of Animal Husbandry and Ministry of Agriculture.

With the establishment of Agricultural Universities in India, Veterinary Colleges were conceived to be established as one of the constituent colleges. These colleges provided a programme of instruction and training in pig production directed towards fulfilling the needs of rural families. These institutes offers opportunity for research related to the changing needs of farmers. These institutes also built up post graduate programme for preparing competent professionals to function as teacher, research worker and extension workers.

The Indian Council of Agricultural Research is concerned with the first line extension education projects and activities. It promptly demonstrates the latest pig production technologies in the farmers fields for influencing the farmers as well as extension workers. It also studies and analyses the socioeconomic and technological constraints which are coming as a barrier to accelerate the pig production. There are many projects sponsored by ICAR namely; All India Coordinated Research Project on Pigs, Krishi Vigyan Kendras, Lab to Land Programme, Tribal Area Operational Research and Socioeconomic upliftment of Scheduled Caste and backward classes.

Ministry of Agriculture, State Departments of Animal Husbandry, Government Pig Breeding Farms and Bacon factories are offering number of training courses in pig production and pork processing which are spread over a period of 15 to 90 days.

National & International Training Courses, Seminar and Workshops.

Course/Seminar/Workshop	Venue/Held
1. FAO Sub Regional Seminar on Pig Production in Tropical & Sub Tropical Regions (21-25 Sept., 1987)	Food & Agriculture Organisation, Suchow (China)
2. International Course on Pig Husbandry, (24th Aug., 88 to 24th Feb., 1989)	Barneveld College, Post Box 64, 3770 AB, Barneveld (The Netherlands).
3. Sausage Making (19-23 Sept., 88)	Central Food Technological Research Institute, Mosore-570013 (India).
4. International Congress "Heart of Technology" Pig Production (14-15 Nov., 1988)	Royal Netherlands Industrial Fair, Congress Bureu, P.O. Box 8500, 3503 RM Utrecht (The Netherlands).

Course/Seminar/Workshop	Venue/Held
5. Quality Control of Meat and Meat Products (14-28 Dec., 1988)	Haryana Agricultural University, Hissar (Sponsored by Ministry of Agriculture, New Delhi).
6. XIth Workshop, All India Coordinated Research Project on Pigs.	Jawahar Lal Nehru Krishi Vishwa Vidhyalaya, Jabalpur-482001 (India).
7. Pork Production & Processing (15-28th Feb., 1989)	Department of Animal Products Technology, Veterinary College, Mohanpur, Department Nadia (W.B.) (Sponsored by Ministry of Agriculture, New Delhi).
8. First International Course on Pig Husbandry (Sept. 4 - Dec. 1, 1989)	International Training Centre on Pig Husbandry, B.O. Marauoy, Lipa City, (Philippines).

12.2 Research & Development

12.2.1 All India Coordinated Research Projects on Pigs

Dr. R.R. Mishra, Project Coordinator and Head, All India Coordinated Research Project on Pigs, Indian Veterinary Research Institute, Izatnagar-243122, (INDIA).

The All India Coordinated Research Project on Pigs was initiated during the Fourth five year plan by the Indian Council of Agricultural Research, New Delhi. The main objectives at the initiation of the project was to provide breeding management support to the imported breed of exotic pigs namely Landrace and Large white Yorkshire for the pig development programme in the country. Accordingly four research centres in North, East, South and Centre region of the country were established with coordinating unit at Indian Veterinary Research Institute, Izatnagar.

Objectives

- i) To assess the performance and heritability of various economic characters of pigs of exotic breeds maintained under optimum conditions and to evolve strains/breeds of pigs suited to various agro climatic conditions by adopting suitable programme.
- ii) To formulate economic rations for different regions.

- iii) To investigate the diseases and to device suitable control measures.

Research Unit APAU - Tirupati

- i) Average birth and weaning weight, litter size and weight were studied.
- ii) Effect of protein, energy and their inter-relationship on performance characteristics and nutrient utilisation in indigenous pigs.
- iii) Efficiency of utilisation of crude fibre by indigenous pigs.
- iv) Nutrient intake of indigenous pigs under scavenging conditions in villages and to evolve low cost feed supplement.
- v) Use of low cost conventional and unconventional feed ingredients to economise the cost of feeding.
- vi) Utilisation of Groundnut Straw replacing maize in the ration for indigenous pigs.
- vii) Study of cross bred (Desi) and indigenous pigs for reproductive performance, carcass trait and efficiency of feed utilisation.

Research Unit JNKVV - Jabalpur

- i) Average birth and weaning weight and litter size and weight were studied.
- ii) Evolving economic rations with locally available feed ingredients like kodo replacing maize.
- iii) The nutritional intake of piglets under scavenging conditions in villages.
- iv) Quantity and quality of supplemental feed necessary to maximise the growth rate of pigs under scavenging conditions.
- v) Study of cross bred (Large white Yorkshire x Desi) and indigenous pigs for reproductive and carcass trait and efficiency of feed utilisation.

Research Unit AAU - Khanapara

- i) Study of average birth and weaning weight and litter size and weight.

- xvi) Processing and preservation of lard.
- xvii) Hygienic standards and microbial quality control of pork and pork products.

12.2.3 Research & Training activities at Ranchi Veterinary College and ICAR Pig Breeding Scheme at Birsa Agricultural University, Ranchi.

Dr. R.L. Singh, University Professor and Chairman, Department of Animal Breeding and Genetics and **Dr. S.K. Singh, Senior Scientist cum Associate Professor,** ICAR, Pig Breeding Farm, Birsa Agricultural University, Ranchi-834007, (INDIA).

Pig Breeding Farm at veterinary college campus also offers practical training for farmers, State Department Officers and Bank Officers for practical knowhow on pig rearing and management. One of the mandates of the veterinary Science College of Agricultural Universities is research besides education and extension. The Agricultural University functions in an integrated manner where education and research are functionally linked. Some important projects running at Birsa Agricultural University are as follows:-

- i) Studies on performance of local and cross-bred pigs (sponsored by ICAR) under farm and village conditions of rearing were conducted. The productive and reproductive performance of crossbreed (Landrace x Desi), Landrace and Desi pigs were studied, Landrace had significantly highest litter size at birth and at weaning and was proved to be the best feed convertor as compared to desi and crossbred pigs.
- ii) Exotic pigs like Tamworth, Landrace and Hampshire were crossed with desi pigs to produce various breed combination with different groups of colour pattern.
- iii) An attempt was made to study on cross breeding on pigs using Large White Yorkshire and Desi pigs.
- iv) Extension education programme on pig breeding was launched. The performance among the indigenous, graded and exotic pigs were demonstrated to the farmers of Bihar State for extension programme. The performance is shown in Table 12.2.3.1.

Table 12.2.3.1.

Economic traits	Indigenous	Exotic	Graded
Mature body weight (Kg) (11-12 months of age)	25-35	90-110	65-75
Litter size at birth	5-6	9-12	7-9
Litter size at weaning	4-5	7-8	6-7
Body weight of day-old piglets (Kg)	0.7-0.8	1.5-1.6	1-1.5
Feed conversion efficiency	5.76:1	4.45:1	4.62:1

The farmers have adopted the improved technology on pig breeding over their native stock.

CHAPTER XIII

DIRECTORY

The Piggery India Year Book 1989 Directory is a list of addresses of Government Bacon Factories, Breeding Farms, Commercial Banks, Consultants, Equipment & Machinery Suppliers, Experts, Insurance Companies, International Pig Breeders, Pharmaceuticals, Slaughter House Corporations and Veterinary Institutions. All Government Pig Breeding Farms listed in the Directory have indicated the names of the Officer-Incharge and breeds of Exotic Pigs maintained.

The Directory is designed to be a reference list of addresses for pig production and processing operation. The Editor would appreciate notification of any additions or changes to the Directory so alterations may be made in future editions.

BACON FACTORIES

Bacon Factory,
Central Dairy Farm,
Aligarh-202 122
(Uttar Pradesh)

Bacon Factory,
Harringhatta-721 436
Mohanpur, Nadia,
(West Bengal)

Government Bacon Factory,
Gannavaram-521 101
(Andhra Pradesh)

Government Bacon Factory,
Kanke-834 005
Ranchi
(Bihar)

MAFCO Bacon Factory,
National Park,
Borivilli,
Bombay-400 022
(Maharashtra)

Meat Complex,
Alwar-301 001
(Rajasthan)

Meat Products of India,
Koothatukulam-686 662
Ernakulam,
(Kerala)

Pork Processing Plant,
Kharar-140 301
(Punjab)

239
BREEDING FARMS

Place	Officer In-charge	Breeds
Andhra Pradesh		
Gannavaram	Dr. K.P. Rami Reddy	LWY
Gopannapalem	Dr. H. Divakar	LWY
Muktalaya	Dr. G. Venkateswarulu	LWY
Padavagi	Dr. H. Divakar	LWY
Tirupati	Dr. K. Krishna Reddy	LWY
Visakhapatnam	Dr. Chanda Rao	LWY
Arunachal Pradesh		
Karsingsa	Dr. P.K. Gogai	LWY, HMP
Loiliang	Dr. J. Bora	LWY, HMP
Assam		
Diphu	Dr. A. Hussain	HMP, LWY, SB
Haflong	Dr. B.K. Dutta	HMP, LB
Kaliapani	Dr. R.K. Goswami	LB, SB, HMP
Khanapara (Univ)	Dr. D.K. Nath	HMP
Khanapara (AICRP)	Dr. A.C. Deka	HMP
Khanapara (Govt.)	Mr. L.C. Tye	HMP, LB, SB
Khanikar	Dr. Rana K Saiky	HMP
Marigoan	Manager	LB, SB
Bihar		
Gaurikarma	Dr. V.K. Mishra	LWY
Hotwar	Dr. C.K. Lall	CB
Hotwar	Dr. N.R.P. Sinha	LWY
Jamshedpur	Manager	
Kanke	Dr. S.S. Verma	LWY, LR, HMP

Place	Officer In-charge	Breeds
Dadra & Nagar Haveli		
Port Silvasa	Dr. D.M. Mumralia	LR
Goa		
Curti Ponda	Dr. H.K. Malviya	LWY
Ela	Manager	
Haryana		
Ambala City	Dr. M.K. Malik	LWY, LR
Hissar	Dr. G.R. Malhotra	LWY, LR
Karnataka		
Hassarghatta	Dr. Kemparaju	LWY, LR, HMP
Koila	Dr. Sreekanth Padke	LWY, LR
Kudige	Dr. T. Channa Krishnaith	LWY, HMP
Kerala		
Ankamaly	Dr. Velayudhan Chengal	LWY
Koothattukulam	Manager	LWY, HMP
Kunnamkulam	Dr. M.L. Joli	LWY
Mannuthy	Dr. Kurien Thomas	LWY
Mundayal	Dr. Rajeevan Nair	LWY
Parasala	Dr. J.R. Nair	LWY
Thalayda Parambu	Dr. Ram Chandran	LWY
Madhya Pradesh		
Bastar	Dr. Dubey	LWY
Jabalpur	Dr. M.M. Mathur	LWY
Sakalo	Dr. M.H. Khan	LWY

Place	Officer In-charge	Breeds
Manipur		
None Tamenglong	Manager	LWY
Senapati North	Manager	LWY
Tarang	Manager	LWY
Torbung	Dr. Ch. Angou Singh	MWY
Meghalaya		
Baghmora	Mr. Thikarson Sangma	SB
Dalu	Dr. S. Ch. Momin	HMP, SB
Jowai	Dr. P. Plani	HMP
Mairang	Dr. G.C. Dutta	SB
Mawryngkneg	Dr. W.T. Passah	SB, HMP
Nongstoin	Dr. S.A. Quddous	HMP
Pynursla	Dr. W. Rygkhlem	HMP, SB, BS
Rongjeng	Dr. N.K. Bora	SB, LB
Rongkhon	Dr. D. Pandey	SB, HMP
Mizoram		
Kolasih	Dr. H. Laltlanmwia	LWY, HMP
Lunglei	Dr. Thangthnama	LWY
Selesih	Dr. Lalnuntluang	LWY
Thenzawl	Dr. Vanlahenga	LWY
Nagaland		
Alukute	Mr. Pihoto Khale	LWY, HMP
Medziphema	Dr. Timothy Lotha	LWY
Merang	Dr. Temsummeren	LWY, HMP
Phek	Manager	LWY, HMP
Suthazu	Dr. Rana	LWY, HMP

Place	Officer In-charge	Breeds
Nagaland (contd.)		
Tijit	Dr. Lolengapang	LWY, HMP
Tuensang	Dr. David	LWY, HMP
Wokha	Mr. Ekyimsao	LWY, HMP
Orissa		
Bhamjnnagar	Manager	
Chiplima	Dr. P.K. Mohanty	LWY, HMP
Punjab		
Badal	Dr. Gurdip Singh	LWY
Chhaju Majra	Dr. H.S. Gill	LWY
Gurdaspur	Manager	LWY
Jalandhar	Dr. Gurmit Singh	LWY
Ludhiana	Dr. Vinay Mohan	LWY
Maltowara	Dr. S. Singh	LWY
Malwal	Dr. T. Pal Singh	LWY
Nabha	Dr. R.S. Kathuria	LWY
Rajasthan		
Alwar	Dr. P. Padmakar	LWY
Bharatpur	Dr. P. Padmakar	LWY
Sikkim		
Gyalsing	Dr. B.M. Chettri	LWY
Tadong	Manager	SB, BS
Tamil Nadu		
Chettinad	Dr. P.P. Thangavalu	LWY
Hosur	Dr. Vaiyapuri	LWY
Pudukottai	Dr. Shanmugam	LWY

Place	Officer In-charge	Breeds
Tamil Nadu (contd.)		
Saidapet	Dr. G. Kovill Pillai	LWY
Udagamandalam	Dr. T.N. Venkatesam	LWY
Tripura		
Amarpur	Mr. SLEEPADA Pattadar	
Birchandramanu	Dr. Babul Chakraborty	
Gandhi Gram	Dr. D. Delepath	
Mendhihaor	Mr. Chander Dhan Sinha	
Nabincherra	Dr. N.C. Das	LR, LWY, SB
Nalkata	Dr. Shyamal Kanti	HMP
Uttar Pradesh		
Aligarh	Manager	LWY
Arzilins	Manager	LWY
Barabanki	Manager	LWY
Basti	Manager	
Dehradun	Manager	
Izatnagar	Dr. Sukhdev	LR
Lalitpur	Manager	LWY
Moradabad	Manager	LWY
Nilgaon	Manager	LWY
West Bengal		
Bijanbari	Asstt. Supdt.	LWY
Haringhatta	Dr. D.P. Chatterjee	LWY, LR
Pedong	Livestock Officer	LWY, LR
Singruntaum	Asstt. Supdt.	
St. Mary's Hill Turki	Manager	LWY
BS: Berk Shire; CB: Cross Bred; HMP: Hampshire; LB: Large Black; LR: Land Race; LWY: Large White Yorkshire, MWY: Middle White Yorkshire; SB: Saddle Black		

COMMERCIAL BANKS

Allahabad Bank, H.O., 14, India Exchange Place, Calcutta-700001.

Andhra Bank, Central Office, Sultan Bazar, Hyderabad-500001.

Bank of Baroda, Central Office, 3-Walchand Hirachand Marg, Ballard Estate, Bombay-400038.

Bank of India, H.O., Express Towers, Nariman Point, Bombay-400021.

Bank of Maharashtra, H.O., 1177 Budhwar Peth, Pune-411002.

Canara Bank, H.O., No.112, J C Road, PB No.6648, Bangalore-560002.

Central Bank of India, H.O., Chandere Mukhi, Nariman Point, Bombay-400021.

Corporation Bank, H.O., Mangaladevi Temple Road, PB No.88, Mangalore-575001.

Dena Bank, H.O., 17 Horniman Circle, Fort, Bombay-400023.

Federal Bank Ltd., H.O., PB No. 103, North Beach Road, Madras-600001.

Indian Bank, H.O., 17, North Beach Road, Madras-600001.

Indian Overseas Bank, Central Office, 151 Mount Road, Madras-600002.

Lakshmi Commercial Bank, H.O., H Block, Connaught Circus, New Delhi.

National Bank for Agriculture & Rural Development, H.O., Dr. A.B. Road, Worli, Bombay-400018.

New Bank of India, The Central Office, 1-Tolstoy Marg, New Delhi-110001.

Oriental Bank of Commerce, The, H.O., E Block, Connaught Place, New Delhi-110001.

Punjab National Bank, H.O., Parliament Street, New Delhi-110001.

Punjab & Sindh Bank, The, Central Office, B-45, Connaught Place, New Delhi.

State Bank of Bikaner & Jaipur, S M S Highway, Jaipur-302003.

State Bank of Hyderabad, H.O., 5-9-187/1, Gunfoundry, Hyderabad-500001.

State Bank of India, Central Office, New Administrative Bldg., Madam Cama Road, Bombay-400021.

State Bank of Indore, H.O., 5, Yeshwant Niwas Road, Indore-452003.

State Bank of Mysore, H.O., Avenue Road, Bangalore-560009.

State Bank of Patiala, H.O., The Mall, Patiala-147002.

State Bank of Saurashtra, Darbar-gadh, Bhavnagar-364001.

State Bank of Travancore, H.O., Trivandrum-695001.

Syndicate Bank, H.O., Manipal-576119.

Union Bank of India, Central Office, 239, Backbay Reclamation, Nariman Point, Bombay-400021.

United Commercial Bank, H.O., 10 Biplabi Trailoka Maharaj Sarani (Brabourne Road), Calcutta-700001.

United Bank of India, H.O., 16, Old Court House Street, Calcutta-700001.

Vijaya Bank, Administrative Office, 2-Residency Road, Bangalore-560025.

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Atkins Das Pvt. Ltd., Planning Engineering & Management Consultants & Architects, 21-Shakespeare Sarani, Calcutta-17.

Cawi Pig Farm Systems, Ruurloseweg 25, 7021 HB Zelhem, (The Netherlands).

Central Food Technological Research Institute, Cheluvamba Mansion, Mysore-570013.

Consultants Group International, Norris Building Burrell Road, Haywards Heath, R.H. 16 ITN, Sussex (U.K.)

Dany Dairy & Food Engineers Ltd., D-51, A, East of Kailash, New Delhi-110065.

Deejay Research & Breeding Farm, St. Patricks Complex, Brigade Road, Bangalore-560025.

Development Consultants Pvt. Ltd., 191, Anna Salai, Madras-600006.

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Emi Verkoop BV, PO Box 8100, 3563 RC Utrecht, (The Netherlands)

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Gujarat Industrial & Technical Consultancy Organisation Ltd., Neptune Towers, Ashram Road, Ahmedabad-380009.

HMFKV Tech. Devp. Company for the Meat Industry, H-1097, Budapest IX, Illatos Ut 7 (Hungary).

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Thangavalu, Dr. P.P., Manager, Piggery Unit, Distt. Livestock Farm, Chettinad (Tamil Nadu).

Thangthnama, Dr., Manager, Pig Breeding Farm, Lunglei (Mizoram).

Thomas, Dr. K., Manager & Officer Incharge, University Pig Breeding Farm, Mannuthy-680651 (Kerala).

Timothy, Dr. M., Manager, Regional Pig Breeding Farm, Madziphema, Distt. Kohima (Nagaland).

Tye, Mr. L.C., Manager, Base Pig Breeding Farm, Khanapara, Guwahati-22 (Assam).

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Pig Breeding Farm, Muktalaya,
Distt. Krishna (Andhra Pradesh).

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Breeding Farm, Kanke, Ranchi
(Bihar).

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of India,** Industrial Assurance
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400020.

National Insurance Company Ltd.,
Head Office, 3-Middleton Street,
Calcutta-700071.

New India Assurance Co. Ltd.,
87-Mahatma Gandhi Road, Fort,
Bombay-400023.

Oriental Insurance Co. Ltd.,
Oriental House, A-25/27, Asaf
Ali Road, New Delhi-110002.

United India Insurance Co. Ltd.,
24, Whites Road, PB No.676,
Madras-600014

INTERNATIONAL PIG BREEDER

Ag-World Exports, RRI Box 39 H,
Bloomington, Illinois 61704 (USA).

Canstock Exports Ltd., RR 22,
Cambridge, Ont., N3C 2V4,
(Canada).

Cotswold Pig Devp. Co. Ltd.,
Rothwell, Lincoln, LN7 6BJ
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Donaldson Intl. Livestock Lt.,
RR 2, Tavistock, Ont. N OB 2RO,
(Canada).

Euribrid B.V., Veerstraat 38, PO
Box 30, Boxmeer (Netherlands).

Fyfe, AR & NG, Box 35, Hamley
Bridge, SA 5401 (Australia).

**Guang Ming Livestock Farm (KT)
Ltd.,** Canton, Kwangchow (China).

Ken-O-Kaw Farms, RRI, Box 133,
Windsor Illinois 61957 (USA).

Masterbreeders Ltd., Pig Improve-
ment Center, Hastoe, Nr. Tving,
Herts, HP 236PJ (UK).

Nieuw-Dalland BV, PO Box 16,
5800, AA Venray, (The Netherlands)

Pig Improvement Co., PO Box 39,
Grong Grong, NSW 2652 (Australia).

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**Alembic Chemical Works Co.
Ltd.,** Alembic Road, Baroda-390003.

Alved Pharmaceuticals (P) Ltd.,
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krishnan Road, Madras-600004.

Cadila Veterinary, Maninagar,
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Cyanamid India Ltd., Nyloc House,
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Glindia Limited, Agrivet Farm Care Division, Dr. A.B. Road, Worli, Bombay-400025.

Herbs (India) Pvt. Ltd., PB No.160, Shardanagar, Saharanpur-247001.

Hoechst India Ltd., Hoechst House, 193 Backbay Reclamation, Nariman Point, PB No.11123, Bombay-400021.

Indian Herbs, Shardanagar, PB No.5, Saharanpur-247001.

May & Baker (India) Ltd., Maybaker House, Worli, PB No.9150, Bombay-400025.

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Pfizer Limited, Express Towers, Nariman Point, PB No.11602, Bombay-400021.

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Roche Products Limited, Vitamin Division, 28 Pt MM Malviya Road (Tardeo Road), PB No. 7901 Bombay-400034.

Sarabhai Chemicals, Marketing Head Office, Veterinary Division, Administration Bldg., 3rd Floor, Gorwa Road, Baroda-390007.

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Wockhardt Veterinary Pvt. Ltd., Poonam Chambers, Shivsagar Estate, Dr. A.B. Road, Bombay-400018.

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A.P. State Meat & Poultry Development Corporation Ltd., Shanti Nagar, Hyderabad-500028.

Bangalore Animal Food Corporation Limited, Victoria Road, Bangalore-560007.

Goa Meat Complex Ltd., Ganga Niwas, Panaji-403001.

MAFCO, Mistry Bhawan, 6th Floor, D.V. Road, Bombay-400020.

Meat Products of India Ltd., Kissan Jyoti, East Fort, Trivandrum-695023.

Punjab Poultry Corporation, Kothi No.517, Sector-33, Chandigarh-160031.

Tamil Nadu Meat Corporation Ltd., 101-A, Anna Salai, Madras-600018.

U.P. Pashudhan Udyog Nigam Ltd., Central Dairy Farm, Aligarh-202122.

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College of Veterinary Science, Ludhiana-141004.

College of Veterinary & Animal Science, Mannuthy-680651.

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